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13. ABSTRACT (*Maximum 200 words*)

Report developed under SBIR contract. The objective of this SBIR project was to define, analyze, and evaluate the current C41 environment in the NSSN and prescribed the information management practices, hardware integration opportunities, and improvements to C41 that could achieve the following goals- improve the quality of decision support information, accommodate new information sources, guide future development, and provide design direction for interfacing subsystems. The SBIR effort was in response to an existing combat systems development environment where new information requirements(to support new missions, information processing capabilities, or sensor technologies) were accommodated within the overall system by the introduction of new "vertical subsystems", and not through exploitation of opportunities to integrate information or by introducing new IM&M capabilities. The approach was to create a multiple axis model of the NSSN C3IS to identify the areas of system design, mission requirements, and information technology that would most beneficially be pursued.

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Technical Report

Submarine Combat System C4I and Information Movement & Management (IM&M) Technology

Small Business Innovation Research (SBIR)
Topic N94-203 Final Report

12 June 1996

Contract No. N00024-95-C-4113

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Introduction

This is the final report of the Darlington Incorporated Phase I Small Business Innovation Research (SBIR) project entitled *Submarine Combat System C4I and Information Movement & Management (IM&M) Technology* (SBIR Topic N94-203). This project dealt with the concept of improving submarine combat system capabilities through the exploitation of IM&M techniques and technologies within legacy and current design systems. This SBIR research effort examined a mix of IM&M practices and capabilities found within the major divisions of the information life-cycle – acquisition, storage, manipulation, distribution, presentation, and archival – and applied them to the submarine combat systems most involved in C4I for emerging submarine mission areas. Specifically, a model was developed that analyzed the interaction of 1) combat system elements (subsystem by functions) used to perform, 2) submarine mission areas, with respect to 3) the information movement and management requirements among the subsystems – to achieve maximum efficiency, fusion, availability, accessibility, and timeliness of the data resident in the various subsystems. Also examined in the Phase I effort was the potential use of intelligent brokers in complex systems as an IM&M technique to be exploited in future systems development efforts.

Contents

This SBIR Final Report is organized into a main report and three appendices. The main body of the report describes the modeling effort and the findings and conclusions relative to the analysis conducted. Appendix A provides a combat system orientation to the model for the Navigation function – demonstrating model outputs and values for navigation system alternatives for three mission areas (i.e., ASW, MIW, and MCM). Appendix B provides a system to subsystem decomposition of the model for the Exterior Communications System (ECS) and components within the ECS for a single mission area (i.e., MIW). Appendix C provides briefing materials that were employed to discuss interim findings with project principals.

Objective of the SBIR Effort

The objective of this Phase I SBIR effort was to develop a technical approach that defined, analyzed, and evaluated the current submarine C4I environment – that is, development of a *model*, to prescribe the information management practices, hardware integration opportunities, and improvements to C4I that must be achieved to meet the following goals:

- Improve the quality (timeliness, accuracy, etc.) and expand the accessibility of current information (e.g., beyond current "stovepipe" system limitations) to better support command decision-making.

- Propose architectural refinements with the necessary collection, processing, distribution, and presentation methodologies to meet the anticipated demand for new information from offboard sources, particularly via the Exterior Communications System (ECS), to support new and emerging missions for the SSN.

- Provide information architecture products (e.g., Data Element Dictionaries, IDSs, etc.) to guide future combat subsystem development and integration challenges.

- Provide a description and model of the information environment to allow design direction for other interfacing or potentially interfacing systems (e.g., Fiber Optic Cable Plant (FOCP), On-Board Tactical Trainer (OBTT), Interior Communications (IC), Non-Tactical Data Systems, Non-Tactical Communications, etc.)

- Explore the realm of middleware to accommodate subsystem interfaces and the ready adaptation of commercially available software products into the existing combat system software architecture to improve information management practices and/or to reduce development time/costs.

The approach to this investigation is represented in Figures 1 through 3, wherein the decomposition of NSSN missions, systems and information technologies leads to elements which can be investigated using a variety of analytical techniques. The method employed to decompose the problem was the Integrated Computer-Aided Manufacturing (ICAM) Definition process modeling methodology known as IDEF0.

IDEF0 Overview

IDEF0 is a graphical modeling technique used to analyze or design complex systems (as used here, a "system" is any combination of functions). Since it is an activity and function based methodology, IDEF0 is particularly applicable to any process-oriented system. The IDEF0 language, components, and techniques are ideal for the depiction of project activities, the relationships between them, their controlling requirements, and the identification of performing organizations. IDEF0 was modified from the Structured Analysis and Design Technique (SADT) that was developed for the Air Force ICAM Program, and has become the DoD CALS standard for the functional modeling (structured definition and analysis) of complex systems. The IDEF0 technique enables an understanding of complex systems and an ability to communicate this understanding to others, by graphically breaking complex systems into less-complex components. IDEF0 may be applied in planning, analysis, design, project management, or whenever a documented understanding of a detailed topic is necessary. The IDEF0 methodology

results in a set of diagrams (also called "the model", discussed below) which is a graphical interpretation of the modeled system's operation and organization.

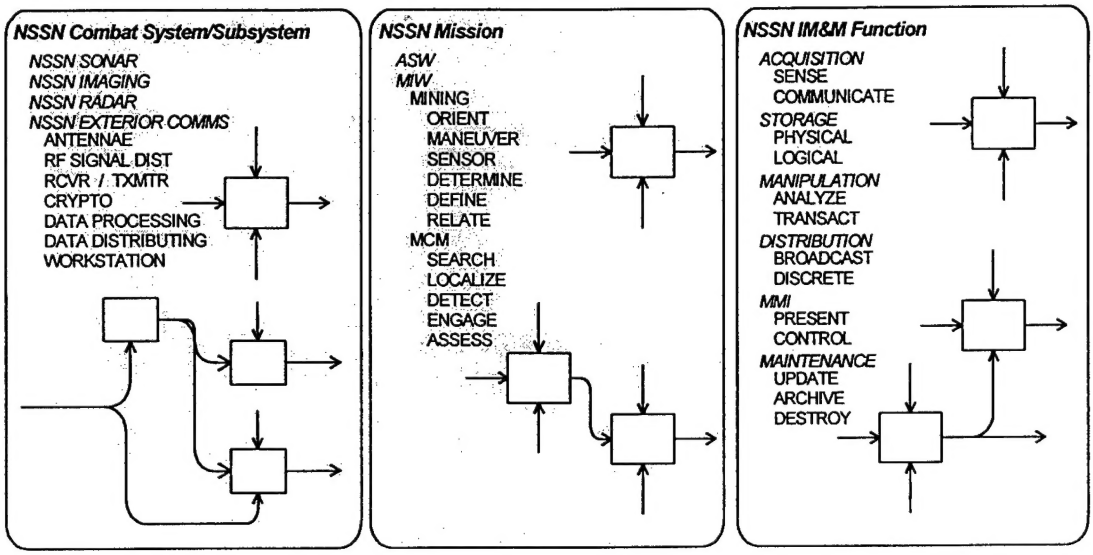


Figure 1 - IDEF0 Decomposition

Diagram (Model) Syntax

Boxes:

Definition: The basic component of an IDEF0 diagram is a box, which is used to represent an activity of the system being modeled. Inputs and outputs to the activity are indicated by various arrows entering and leaving the sides of the box. These arrows can represent inputs, controls, outputs, or mechanisms (ICOM).

Attributes:

(1) Name: A verb or verb phrase used to describe the activity.

(2) Inputs: Resources necessary to carry out or complete the given activity enter the left side of the box.

(3) Outputs: Resources produced or modified by the activity exit the right side of the box.

(4) Controls: Constraints on the activity enter the top of the box.

(5) Mechanisms: Tools (people, facilities, equipment, etc.) required to accomplish the activity enter the bottom of the box.

(6) Position: Typically (but not always), the relative position of a box indicates the importance that an activity has to the rest of the system. The most important boxes are placed to the left and above the other activities.

Arrows:

Definition: Arrows representing inputs, controls, outputs, and mechanisms (ICOMs) are used to connect the activities into a system network.

Attributes:

(1) Label: A noun, or noun phrase, that describes the represented input, control, output, or mechanism.

(2) Source: The originating activity of the input, control, output, or mechanism.

(3) Sink: The receiving activity of the input, control, output, or mechanism.

Layout and Relationships

The diagram in an IDEF0 model is organized in a hierarchical and modular top-down fashion, eventually depicting the system divided into its component parts. The application of an IDEF0 model starts with the most general, or abstract, top-level system description and is progressively broken down into more detailed activities. The system is decomposed into its component parts until it is described at the desired level of detail. At each stage of the system, the higher-level diagram is said to be the "parent" of the lower-level (more detailed) diagrams, the "children". For the SBIR effort, an IDEF0 analytical model of the NSSN C3IS subsystems, Missions, and Information Movement and Management (IM&M) functions (the "parents") was developed that allows marginal utility comparisons of discrete functional groupings. The model, as an example, gives a quantitative indication of the involvement of IM&M magnetic media storage functions (an example of "children"), within the Mine Warfare target acquisition functions ("children") occurring within the ECS UHF data distribution equipment functions ("children"). This capability to compare functions across the spectrum of NSSN C3IS architecture, will allow further analysis of efficiency, reliability and interoperability in the comparison of candidate methods of performing required functions. Questions of tradeoff among competing technologies or even equipment can be analyzed through this multidimensional model using multivariate analytical techniques, such as factor and cluster analysis and multidimensional scaling.

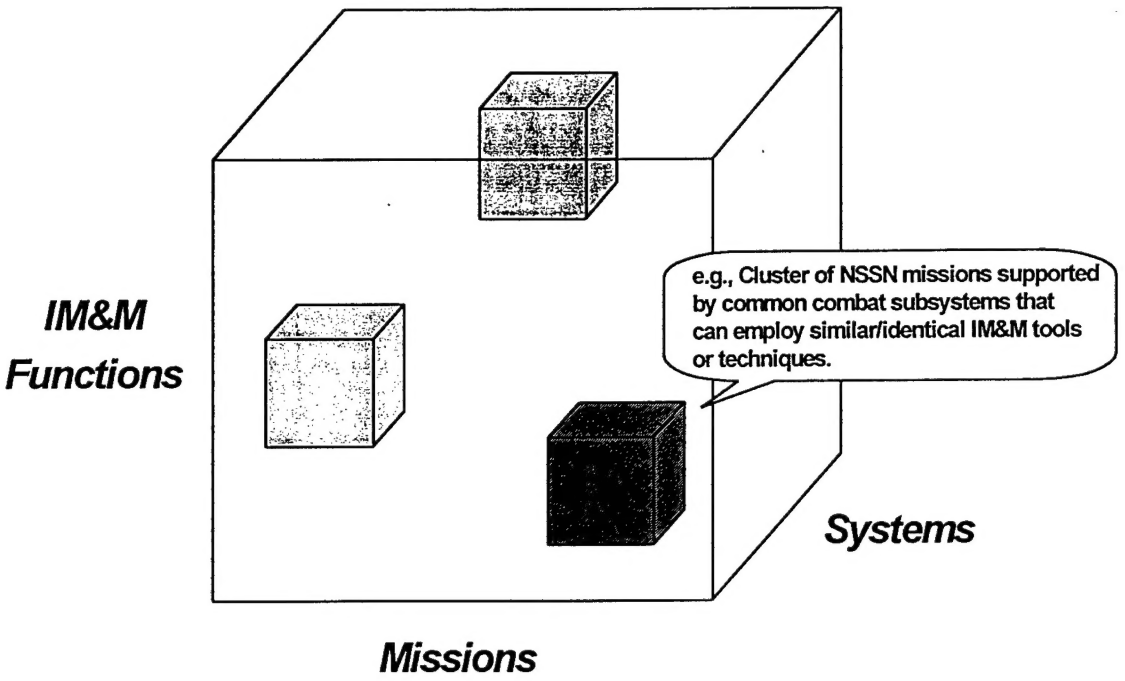


Figure 2 - Factor and Cluster Analysis

This objective has been achieved through the use of established system engineering tools, general purpose analytical tools such as Quattro Pro spreadsheets, and graphical tools to display results. These tools included IDEF0 modeling techniques, ERWin entity creation using IDEF1X with resultant Data Element Dictionary, and finally multivariate analysis of a model in three dimensions. The unique application of this SBIR was that these tools were used in such a manner that each successive tool used in the steps of analysis created a compatible input for the next tool. This SBIR effort used commercially available applications to analyze NSSN C3IS architecture and mission areas to determine promising areas for IM&M technology insertion.

As a note of distinction between IDEF0 and IDEF1 – and the IDEF1X employed in the SBIR project, it is useful to contrast the various features of the IDEF technique. IDEF1 is used for information modeling to capture conceptual views of an enterprise's information. It is an analysis method to capture, communicate, analyze, and understand the information needs of the enterprise. These models simply identify the enterprise's concepts of information such as department and employee (or, system/subsystem in the combat system) and the concept that there is a relationship between the two, such as employee works in a department. IDEF1 is not a method for designing the database, but is a tool for the enterprise to understand the information it deals with, so information resource management can be supported. In contrast, IDEF1X is used for data modeling, which captures the logical view of the enterprise's data and is based on an entity relationship model. It is a design method for logical database design once the

information system requirements are known. The focus is on the actual data elements of the information system to be developed.

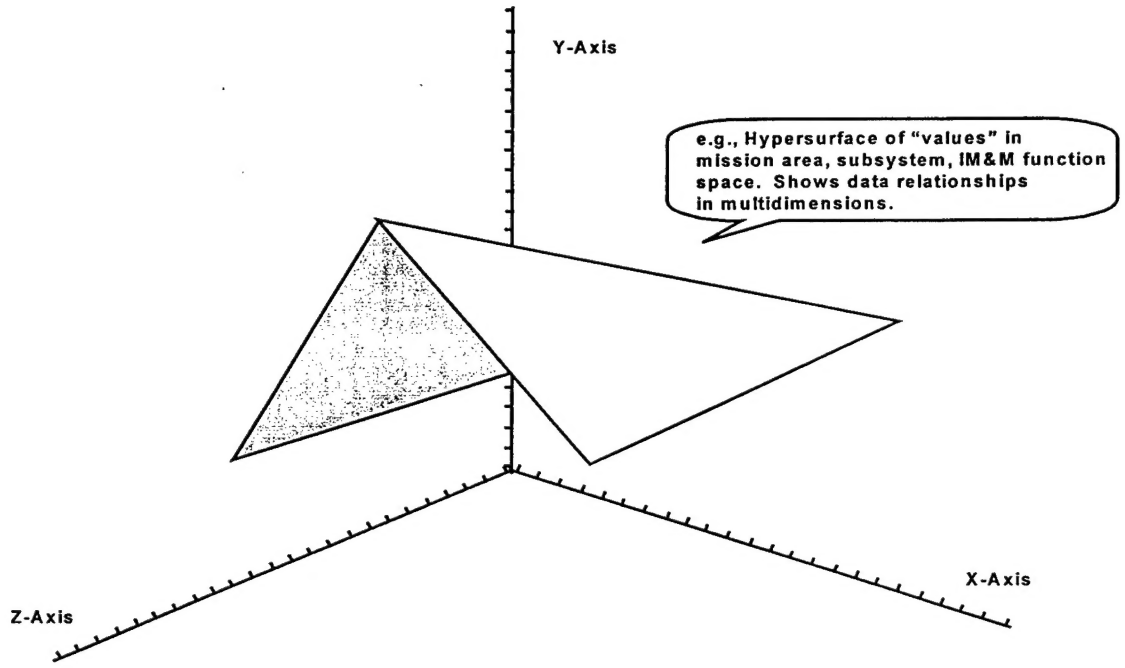


Figure 3 -- Multidimensional Scaling Analysis

This initial phase of the NSSN C3IS model has demonstrated benefits of IDEF1X modeling of a complex information system architecture to investigate relationships among system architecture, mission requirements and information technology. The follow on work of the second phase of this SBIR will take these initial investigations into a more dynamic hardware based model of the NSSN C3IS, working with data in real time or applying specific IM&M technologies across multiple combat systems.

Foundations of Analysis

This section of the report discusses the evolution of the SSN C3IS information management model. An attempt to create a quantitative model that spans the broad scope of the NSSN C3IS must be based on fundamental concepts. The most fundamental concept is that the NSSN C3IS can be represented in terms of its missions, subsystems and information technologies. This concept is well founded as a precept of engineering design starting with mission element needs statements. Historically missions are analyzed down to a function level from which function requirement documents lead to system, subsystem and component design. The decisions to implement the function requirements using a given technology, specifically information technology are not as clearly reflected in the system design.

This study applies the same concept of mission element versus system functions correlation through a two dimensional array and adds a third dimension for information technology. By decomposing each of the array axes to a sufficiently detailed level, the functions of mission, system and information technology should provide significant correlation, particularly in the development of information technology options to be implemented across system and mission boundaries. The considerations during the decomposition of these axes are discussed below.

Systems

The creation of the NSSN C3IS model requires a decomposition and comparison of functions relating to missions, systems, and IM&M technologies. The systems to be analyzed for decomposition are considered subsystems of the NSSN as described in the New SSN Command and Control System Functional Description Document (FDD) dated 01 October 1994. As the FDD presents an initial and not very detailed C3IS description, and one which was expected to change as the design development progressed, this C3IS configuration was analyzed and decomposed using legacy equipment where new design documents were unavailable. An example of this consideration is found in the FDD description of CC as supporting Tomahawk – without identifying the possibility of using the developing ATWCS as planned in CCS Mk-2. Another example is the description of the Radar subsystem utilizing the AN/SPA-25G display with no mention of the AN/UYQ-70 console for this function. Even though the design development process for NSSN was expected to produce changes to the C3IS the following starting configuration of the NSSN C3IS was employed to get model development started.

Initial NSSN C3IS Subsystems

- Combat Control (CC)
- Sonar
- Imaging
- Electronic Support Measures (ESM)
- Radar
- Exterior Communications System (ECS)
- Submarine Defensive Warfare System (SDWS)
- Interior Communications (IC)
- Navigation (NAV)
- Non-Tactical Data Processing System (NTDPS)
- Fiber Optic Cable Plant (FOCP)
- Total Ship Monitoring System (TSMS)
- Tactical Support Device System (TSDS)
- Navigation Sensor System Interface (NAVSSI)
- Acoustic Intelligence (ACINT)

- Identification Friend or Foe (IFF)
- Unmanned Undersea Vehicle (UUV)
- Tactical Acoustic Communications System (TACS)
- Onboard Team Trainer (OBTT)

These subsystems were further decomposed, first by equipment designations, and then to the level of discrete functions within the equipment.

Legacy Systems

The approach for this SBIR effort was formulated concurrent with the design development of NSSN C3IS. The target subsystems were known in name and function, however subsystem allocations and design details were not yet finalized. Moreover, the actual methods of performance and the equipment to perform the C3IS functions were unknown. As this analysis progressed the NSSN C3IS design development matured and target systems and equipment were identified. This presented, and continues to present as we move into the second phase of this SBIR effort, a challenge of configuration migration within the model to stay current with the NSSN C3IS maturation. The approach of legacy system analysis and decomposition, as discussed in Brodie and Stonbraker, *Migrating Legacy Systems,* has been selected to insure maximum reuse of resultant functional descriptions as the legacy functions migrate to the target subsystems. The concurrency with Brodie and Stonbraker descriptions strengthens the underlying goal to provide recognized information architecture products for reuse in later design efforts.

In applying the techniques described by Brodie and Stonbraker, it must be realized that this study considers the early model entities and attributes as a whole to represent a legacy body of information. This legacy information continues to migrate incrementally within the model as the NSSN C3IS design development process matures. In our case the early model legacy information is considered to be decomposable allowing the forward migration method described by Brodie and Stonbraker. This forward migration method can be considered the model configuration management of changes to the System, and possibly to the Mission, axes.

The Brodie and Stonbraker incremental migration method consists of eleven steps. (Each step is performed in an incremental fashion to focus efforts on selected portions of the overall system.)

- Analyze the Legacy Information System (IS)
- Decompose the Legacy IS Structure
- Design the Target Interfaces
- Design the Target Applications
- Design the Target Database
- Install the Target Environment

- Create and Install the Necessary Gateways
- Migrate the Legacy Database
- Migrate the Legacy Applications
- Migrate the Legacy Interfaces
- Cut Over to the Target IS

The application of Brodie and Stonbraker incremental migration in this study started with steps one and two completed, as result of the model formulation. As the NSSN C3IS design development proceeded, revealing new equipment such as ON-143(V)14 integration into the USQ-70 console, steps 3 through 11 of the above process allowed functions that resided in legacy equipment such as ON-143(V)6, GFCP, and SB3890 to be mapped into their respective new places in the model.

Mission Axis

The mission axis of the model cube was populated by decomposing mission through warfare areas, functional areas and then to functions. These mission functions, when taken to a sufficient level of detail become drivers of the functions of the system axis. In general, the mission functions should be fulfilled by system functions. The decomposition of SSN mission starts with the divisions of warfare areas. The initial selection of warfare areas for inclusion within the SSN C3IS model were selected from the overall list of warfare areas listed in Table 1 presented below.

Table 1: Candidate NSSN Mission Areas

AAW	ANTI-AIR WARFARE
AMW	AMPHIBIOUS WARFARE
ASU	ANTI-SURFACE WARFARE
ASW	ANTI-SUBMARINE WARFARE
CCC	COMMAND, CONTROL AND COMMUNICATIONS
CON	CONSTRUCTION
ELW	ELECTRONIC WARFARE
FSO	FLEET SUPPORT OPERATIONS
INT	INTELLIGENCE
LOG	LOGISTICS
MIW	MINE WARFARE
MOB	MOBILITY
NCO	NONCOMBATANT OPERATIONS
NSW	NAVAL SPECIAL WARFARE
STS	STRATEGIC SEALIFT
STW	STRIKE WARFARE

The warfare areas of ASU, ASW, CCC, ELW, MIW, NSW and STW were selected for the NSSN C3IS model. These warfare areas were subjected to the process of decomposition as shown in the instance for ASW below.

ASW

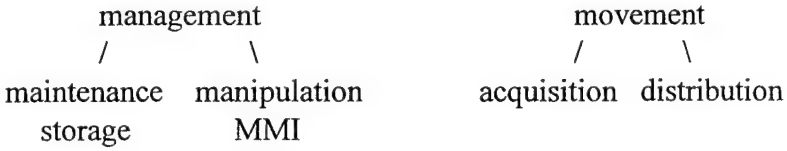
- *Search*
  - Orient
  - Maneuver
  - Sensor
  - Determine
  - Define
  - Relate
- *Localize*
  - Orient
  - Maneuver
  - Sensor
  - Determine
  - Define
  - Relate
- *Detect*
  - Orient
  - Maneuver
  - Sensor
  - Determine
  - Define
  - Relate
- *Engage*
  - Orient
  - Maneuver
  - Sensor
  - Determine
  - Define
  - Relate
- *Assess*
  - Orient
  - Maneuver
  - Sensor
  - Determine
  - Define
  - Relate

Technologies (IM&M Function Axis)

The analysis and decomposition of IM&M functions axis progressed from the general descriptions given by Bernard H. Boar in *The Art of Strategic Planning for Information Technology* and then used more detailed functions associated with current technologies to enhance the IM&M hierarchy. An example of this approach is to take the general functions of information management and movement to the next lower level and then enhance these descriptors with more detailed functions found in current technologies. Boar's next lower echelon presented the IM&M functions; transmission, storage, preparation/presentation /collection, and processing/transformation. As result of model axis development in this study Boar's functions have been replaced with maintenance, storage, manipulation, MMI, acquisition and distribution. These function titles were selected to enhance the hierarchical decomposition using IDEF0 methods.

The selection of Boar's model of IM&M for insertion into the traditional matrix comparing warfare mission functions with system capability functions supports the approach of each model tool being compatible with the next tool to be used. Boar's model is well suited to technology assessment and resource investment decisions, as well as decomposition of IM&M functions. Therefore, in addition to supporting the continuity of the model structure, this model of IM&M functions may provide insight regarding efficiency of NSSN C3IS costs within various subsystem functions. Although somewhat tangential to this analysis, an interesting question to present to the IM&M / System matrix would be, "How many times are the same IM&M functions applied within different subsystems, yet paid for separately with no enjoyment of reuse?"

Network technology, as an example was analyzed for application to acquisition and distribution.



Other candidate technologies for analysis included:

- Networks and Busses
  - Middleware
  - Software Agents
  - Mobile Brokers
- Magnetic media
  - Memory
  - Bulk

- Virtual Diagnostics
- PDA
    - Communications
    - Computation

Networks

Although the NSSN C3IS design development considered both LAN, bus, and point-to-point architectures, the primary emphasis during the early stages of this analysis was on LAN architecture. The decision to concentrate on LANs was based on the expectation of seeing more model interactions among different warfare mission areas across a LAN (or point-to-point connections) than on a bus. The decision should not imply a preference of LAN technology to bus technology. This emphasis is evident in the decomposition of the IM&M axis as well as the System axis in the model cube – specifically, the FOCP is delineated as both a "system" in the model construct, as well as an "IM&M technology". The methods of information distribution (movement) planned for the NSSN include Local Area Networks, e.g., Ethernet, FDDI and potentially Flexnet topologies, and bus architecture including VME, VXI and other bus standards embedded in system processors. Among these methods of physical transport, and among the related protocols such as Asynchronous Transfer Method, Token Ring, and Transport Control Process/Internet Protocol (TCP/IP), we also analyzed concepts such as middleware functions, software agents, and intelligent brokers to improve IM&M functions.

Magnetic Media

Information storage in the physical sense was analyzed using the concepts of magnetic media technology. Even though non-magnetic media were considered during the decomposition of the IM&M and System axes of the model cube, the underlying functions of magnetic and non-magnetic technology were considered sufficiently similar to allow extensive model analysis using this limitation of scope. Of greater concern were the concepts of volatile or non-volatile storage, cache for random access memory, shared memory, and high volume data storage with rapid access.

Analytical Methods

The second fundamental concept of this study is the application of multivariate analysis methods to a multidimensional array of subjective factors. It is important to realize throughout this study that the application of quantitative methods to analyze subjective data cannot result in one right answer. The concept at work here is that the structure of the model and the analytical methods that were used to compare the factors of the model are visible to the researcher and can be varied to investigate the significance of information technologies applied in NSSN C3IS design. This concept is discussed in detail in the following paragraphs.

Phase I was originated with the idea that the technical approach to NSSN development could be systematically decomposed in a manner that would help focus attention on areas of greatest potential for payback of research and development expenditures. The decomposition would display the NSSN program along three axes: Mission, System, and Information Management. These axes are clearly interrelated, but the Phase I approach was based on the premise that by addressing each of these areas individually, that information management concepts would be identified that were applicable across NSSN missions and systems. Furthermore, a methodology that addressed this data could perhaps be of use in analyzing research and development needs of other complex programs.

To deal with the large body of data that could arise from this analysis requires some methods for data reduction and visualization. The step noted above, that is, decomposing the program into mission, system, and information management components, is itself a useful start on data reduction, and would hopefully demonstrate some patterns of interest by inspection. Within each axis, further systematic decomposition yielded attributes for further discussion and analysis, as displayed in the section on analysis. Although the method used to obtain this decomposition was expert judgment, the application of this judgment in a constrained format was thought to be of value. Finally, once the NSSN program was decomposed qualitatively, it was desirable to assign numerical scores to each element of the resulting multidimensional array in a manner designed to allow application of analytical and graphical techniques that would highlight areas of importance.

Multivariate Statistics

From the above description, it became apparent that multivariate statistics could yield analytical tools of value in the quantitative analysis of the programmatic multidimensional array. Multivariate statistics include a variety of techniques to analyze dependence of scalar values (statistics) on multiple input values. These techniques include such techniques as factor analysis, discriminant analysis, cluster analysis, multidimensional scaling, in addition to multivariate versions of such classical statistical techniques as tests of significance, analysis of variance, and regression analysis. Although the methods are not totally distinct, and are in some cases rather loosely described in the literature, with details left to specific implementations as computer programs, Phase I concentrated on methods related most closely to cluster analysis and multidimensional scaling.

One reason for the attention to these techniques is their mutual dependence on some common analysis of distance, as will be evident in the following description. Individually, however, they also seem closest to the desired methodology. Cluster analysis is a general term describing a variety of methods which attempt to group objects into classes, where the number and nature of the classes is not known *a priori*. After

clustering, the objects in a class should be more "similar" in some sense to one another than they are to objects in a different class. The intention of Phase I was to cluster objects related to the NSSN program so that one could distinguish those which would jointly benefit from technology insertion, and could discriminate the clusters which would receive higher payoff from such insertion than those which would benefit less, or require greater resources for a like benefit.

Multidimensional scaling attempts to use the measures of similarity between clusters to reconstruct a map of relationships among them that could explain or allow one to visualize their similarity. Such maps are not, in general, unique given the similarity data, but could provide a valuable visualization tool.

Objects

Before one can define variables, measure those variables, and compute statistics as functions of those measurements, one must first identify the objects of interest to the analysis. Objects in this sense are rather abstract, and can take a diversity of forms. They are the entities or things that we can define and create boundaries around, perhaps artificially. An object to us will be a carrier of characteristics, and is defined by those characteristics.

What are the objects in the Phase I analysis? As a first step, we will consider an object to be a triple of descriptors: (mission, system, information management). Note that the triple is descriptive, not quantitative. An example of such a triple might be (...,...,...)

The three dimensional array presenting Phase I objects is quite large. With m missions, s systems, and i information management categories, we see that there are $m*s*i$ possible objects in the analysis. Tractability of the analysis requires a simplification to some extent; although the purpose of the analysis is itself to reduce the complexity of the data, some preprocessing may be required to reduce the number of objects to describe and analyze to a manageable level. We can do so in at least two ways: *ad hoc*, or systematic aggregation.

Ad hoc simplification takes advantage of the analyst's knowledge of the problem to focus on a sub-problem of interest. The drawback to this sort of simplification is that it eliminates data from participation in further analytical steps, and can be justified only to the extent that the reviewer trusts the analyst's judgment in the matter. Since Darlington, Incorporated has subject matter experts relevant to the Phase I analysis, such an *ad hoc* simplification may be appropriate. The advantage of such simplification is that it eliminates the need to elicit the huge number of values for variables measuring inappropriately high resolution details of the analysis. Furthermore, as noted later, the

variables in this analysis are, themselves, subjectively scored, so ad hoc simplification merely passes the subjectivity to a higher level of the analysis.

Systematic aggregation would simplify the number of objects to be passed to the next level of analysis by procedurally aggregating small objects into larger ones. In the case of the Phase I analysis, once scores (measures) of variables associated with individual objects are given, one could consider accumulating those values into measurements of aggregate objects such as a rectangular region of space containing the individual objects. Two choices seem particularly appealing here: (1) uniformly aggregate regions of a fixed size (e.g., 10x10x10 cubes) or (2) aggregate according to problem specific boundaries (e.g., aggregate the lowest level mission, system and information management descriptors to the next level to which they belonged before decomposition).

One might ask why one would aggregate rather than simply stopping the decomposition at a higher level originally. The advantage of doing so is the flip side of the advantage of *ad hoc* aggregation: where the latter allows one to avoid taking as many measurements, the systematic aggregation process allows one to extend the (possibly subjective) measurement process to finer details, and then to make use of that data in a systematic manner. Whether to do so will depend to a large extent on the degree to which the analyst feels confident that the finer measurements are, in fact, within the precision with which the problem can be accurately described. Trade-off with the level of effort required by the measurement step is also relevant. Regardless of the specific aggregation method or level of aggregation, Phase I suggests that the aggregate be scaled numerically. For example, if individual measurements are thought of as weights, then the aggregates might be computed as densities, or average weights per unit volume. In the example above, where 10x10x10 cubes are aggregated, the resulting measurement can be divided by 1000. The value of doing so is that the results are normalized to whatever boundaries we choose. If we aggregate to different boundaries, or aggregate iteratively to ever higher levels of hierarchy, we still follow the same procedure and get comparable results in later stages of the analysis.

Variables

Objects of the analysis are the abstract entities of interest; in the Phase I SBIR they are the descriptor triples defined above. Variables are quantities that can take different values that characterize the objects. "Values" and "quantities" in this context may have a variety of meanings: although it is common that they be numerical, a variable may have its range in any set (e.g., its values may be colors).

Measurement

Measurement is the process of associating specific values with objects. Again, in the context of analysis such as conducted in the Phase I SBIR, measurement is a more abstract notion than the common use of the term. Where in ordinary use measurement refers to comparison with an objective, normative scale of reference values, with "nice" mathematical properties such as being ordered, permitting computation of meaningful ratios, and the like, measurement in the sense of statistical analysis need not have these properties. In particular, "measurement" can refer to a subjective assignment of values. Such values may have common references only to the extent that they are assigned by the same analyst, and are relative therefore to the same judgment. Some analytical methods that incorporate subjectivity attempt to retain some of the valuable mathematical characteristics of objective measures. For instance, traditional decision analysis using utility theory ensures that the resulting decisions retain certain properties deemed "rational". These include transitivity, in other words the property that if decision A is preferred to B, and B to C, then A will be preferred to C. While these properties do seem desirable, it is also well known that it is mathematically impossible to take such utility functions for individuals, and guarantee that the "rational" properties will be retained when they are extended to a group utility. It is also a difficult task to elicit accurate utilities, and to have confidence in the multiattribute case that they accurately reflect all the factors of importance to the decision-maker. Even in this rather rigorous subjective measurement method, it is not intended that the method predict the behavior of the decision-maker, just that it guide such behavior if the decision-maker agrees that the model reflects the important problem attributes and agrees that it would be desirable to retain the "rational" properties preserved by the method.

In the case of the Phase I SBIR, an *ad hoc* subjective method was chosen to codify relative importance of each object descriptor, relative to all other objects and to an implicit statement of objective associated by the analyst with the object being measured.

For each object (*m*, *s*, *i*), variables (x, y, z) were assigned values such that: $0 <= x, y, z < 4$. The values are ordered for each variable. That is, if two distinct objects with mission components m1, m2 have mission variables x1, x2 respectively, and if $x1 < x2$, then we would interpret that that mission 1 is less important as a factor in object 1 than mission 2 is with respect to object 2. As noted above, these judgments are relative to the objective of each object, and relative to the importance of system and information management components to those objects as well. The measurement doesn't necessarily guarantee that if $x1 < y1$, where x1 is a mission variable and y1 a system variable, then mission is less important to object 1 than is system. Obviously this also means that if $x1 < y2$ then one can't infer the relative importance of mission and system components in the two distinct objects.

Despite this limitation, an acknowledged weakness of the Phase I definition of measured values, the actual measurements are relatively consistent since they are the product of an individual analyst with informally applied judgment standards.

Phase I effort demonstrated to the analyst that this was a weak point of the method in that it left unspecified and unseen the objective statement against which the values were assigned, and that the process of assigning values was in itself rather idiosyncratic and not subject to objective standards. Nonetheless, it is impossible to say that such values are any worse than the values that would be assigned in a different, still subjective manner. The particular measurements assigned by Phase I, and more generally the method of measurement, should be considered examples for the purpose of demonstration, realistic to the extent that the analyst is indeed familiar with the content of the NSSN program, and is a replaceable component of the analysis method. Future applications of the analysis method of Phase I can replace this measurement method with any other and still apply the balance of the technique unchanged.

Distance or Similarity

Distance is important in the Phase I analysis as a method of preprocessing raw measurements into a form applicable to both cluster analysis and to multidimensional scaling. Distance in this sense is a measure of closeness, or similarity among elements of a set (points); distance is in essence the inverse of similarity. In principle, distance could be the measurement or value of the variables associated with an object. For instance, the analyst could be asked to directly assign a value with the properties of a "distance" among pairs of objects. In the case of the Phase I SBIR, the assigned values do not really have the appropriate properties; distance is instead computed as a function of variables in an additional step.

Distance in mathematics is metric

Mathematics has an abstraction of distance known as a "metric", with the following properties:

metric, d, is function:

d(x,y) in R for all x, y in non-empty set X (metric space)

d(x,y) >= 0

d(x,y) = 0 <=> x=y

d(x,y) = d(y,x)

d(x,z) <= d(x,y) + d(y,z)

In words, a metric is a nonnegative function of two points from the set in question, which is zero if and only if the points are identical, which is symmetric (i.e., independent of the direction in which you measure between the points), and obeys a rule known as the "triangle inequality", which roughly states that it can't be shorter to be routed through a third point than to go directly from one point to another. There are many mathematical formulas that compute varying values for distance, but they generally obey these same abstract rules, and thus are believed to capture the appropriate notion of distance.

pseudo-metric, d

A related mathematical notion which relaxes the requirements for a metric is a "pseudo-metric", with the following property:

Like metric but doesn't require d(x,y) = 0 => x=y

Any metric is also a pseudo-metric, but a pseudo-metric may have multiple points at a distance of zero from each other.

Pseudo-metric can be metricized by forming equivalence classes of sets of points with d(x,y)=0

The difference between a pseudo-metric and a metric space can be "repaired" by equating sets of points that are at distance zero from one another and considering them as if they were identical. In the current context, we would say that if two points were so similar as to have zero distance, then we might as well consider the associated variables or objects as indistinguishable.

d(x,A) where x is point, and A is a set in a metric space X

Defined by d(x, A) = inf(glb) { d(x,y): y in A }, that is that the distance from a point to a set is the greatest lower bound on the distances from that point to each of the points in the set.

Similarly, one can define the distance between two sets by d(A, B) = glb { d(x, B): x in A }

Set distance is of interest to the Phase I analysis, in that it can aid in characterizing sets of objects or variables that are highly interrelated (similar) compared with their similarity to objects or variables from another set (cluster analysis).

Subjective assessment of distance

obviates need to measure variables initially, direct to distance

sometimes creates need for multidimensional scaling, i.e., to recreate map of relationships, given subjective, pairwise assessments of distance

Specific distance computation

For the purposes of the analysis of Phase I, and more generally of cluster analysis and multidimensional scaling, there is no requirement that the distance computation be a metric. Among metrics, there is a wide range of possible functions. Thus, the distance computation is another parameter of the Phase I analysis, which need not be replicated in a future application. We should note, however, that the infinite variety of metrics in finite-dimensional space are essentially equivalent, in the sense that they impose similar notions of "closeness" from a mathematical (topological) point of view. They differ geometrically, however. For convenience and because it's a commonly used metric, Phase I used the usual Euclidean distance:

$$d(a,b) = \sqrt{(x_a - x_b)^2 + (y_a - y_b)^2 + (z_a - z_b)^2}$$

Cluster Analysis

This technique associates objects with relatively great similarity and distinguishes the grouping from others which are, as a group, dissimilar. The notion of similarity is based on the distance computation, as described above. It is essentially a minimization of distance among objects within a group and maximization of distance between groups of objects. Cluster analysis is related to factor analysis, in which grouping is on the basis of variables rather than objects. Among the differences among clustering techniques are whether they aggregate smaller groups into larger ones, starting with individual objects or whether they begin with one large group, decomposing into smaller clusters of objects. Defining stopping points (how many clusters, thresholds of distance at which distinct clusters are identified, etc.) is also a variable of the analysis. Cluster analysis is not that well documented, appears to occur in a diversity of variants, and is most clearly defined according to some authors by the details of computer programs implementing the specific analysis. Some authors refer to cluster analysis as a "black art", and point out that it may not yet be refined enough to identify clusters that wouldn't appear at least as clearly to the naked eye. The Phase I SBIR also identifies the possibility that such visual analysis may be aided by color coding, similar to thermography, and may suffice as a form of cluster analysis, or in lieu of such analysis.

Multidimensional Scaling

Multidimensional scaling also uses distance data to reduce a data set, but in a different manner than cluster analysis. It follows from the following observation: if a data set precisely fits along an n-dimensional curve, one could fit the curve, and reconstruct

the number of dimensions needed to represent the data. For most statistical data, however, the fit to a curve is only approximate. If the goal is to fit the data well enough, and use a small dimension curve to do so, there may be tradeoffs of fidelity of the reconstructed "map" to the original data. Furthermore, even if the fit is precise, there are transformations of the map that would accommodate the same data equally well. For example, rotations of the map don't change the dimensionality of the representation at all. Nonetheless, multidimensional scaling appears to have some value as a way of constructing hypothetical maps from distance data, giving a schematic representation of the relationships among the points that model at least their relative closeness well.

Model

The NSSN C3IS model developed in accordance with the foregoing analytical precepts is a three dimensional array of functions presented along the axes of NSSN Mission, NSSN C3I System, and IM&M. As discussed above, the model of the NSSN C3IS was developed using IDEF0 to decompose the three areas of interest into functions. Although IDEF0 is a modeling application which displays models in two dimensions, an adaptation of IDEF0 was used to populate the cells of the three dimensional array.

The IDEF0 procedures used in developing the NSSN C3IS model include the Context Diagram, Node Tree, and Decomposition Diagram. The Context Diagram is a model of the NSSN C3IS at the highest level. The Context Diagram is roughly equivalent to the WBS level 0 in defining function requirement documents. The Node Tree is a hierarchical line chart displaying the relations of the various levels of the NSSN C3IS functions. The Node Tree displays about the same information as the WBS. The Decomposition Diagram, using ICOM shapes and arrows, shows functions as they are decomposed from layer to layer, along with the factors of input, conditions, output and mechanism to express the relations among the NSSN C3I model functions. Examples of these diagrams are shown below.

Model Structure

The current structure of the NSSN C3IS model is maintained in a Quattro Pro workbook containing *m* sheets, each containing *s* rows and *i* columns. The cells of the sheets are defined by the level five functions of the decomposition of each of the axes in the model. The initial approach to quantifying the model cells was to determine the level of significance for each function as it intersects with other functions. This approach lead to the spreadsheets represented in the following example. These spreadsheets show the intersections of Global Positioning System and Ring Laser Gyro System, with ASW and MIW warfare functions, and IM&M functions. The model outputs for the Navigation function for ASW and MIW are presented in Appendix A to this report.

Analysis of Model Interrelationships

The techniques of analysis used in the NSSN C3Ismodel include cluster analysis and multidimensional scaling. The cluster analysis methods were used to reduce the overall analysis to regions within the model where multidimensional scaling methods were used.

Cluster Analysis

The NSSN C3IS model provides a physical and a logical structure for cluster analysis, as discussed above. The physical structure is comprised of the three dimensional coordinates of the cells formed by the intersection of the mission, system and IM&M axes. The logical structure is comprised of the relationships among the values contained within the cells. The physical structure of the model, when subjected to 3D graphics tools such as Polyray or VRML, provides a visual representation of the location and scope of clusters of similar values among the model cells. The logical structure uses the pattern matching capabilities of tools such as AWK and PERL to compare the sameness of cell values and record the coordinates within the model.

The analysis of the physical structure of the model depends on a visual interpretation of the values within the cells. The initial population of the model was selected to show the significance of each component of mission, system and IM&M. These components were represented by values ranging from 0 through 3. The 64 possible values from 000 through 333 can be shown as varying shades of white (333) clouds within a black (000) background, or they can be shown as hues of combinations of red, green and blue. The boundaries of the clusters is provided by the visual contrast of colors among the cells within the model. This method of analysis provides a quick cursory resolution of very large amounts of data.

The analysis of the logical structure of the model results in a tabular list of cells that contain the same values and that are bounded by cells of different values. This treatment of the values within the cells effectively creates contrast by identifying the boundaries of groups of similar and groups of dissimilar cells. This method of analysis provides an exact but time consuming comparison of all cell values. This method is best used within a defined region of the model.

Multidimensional Scaling

The NSSN C3IS model provides many regions of interest for further analysis. The initial region selected for the first phase of this SBIR is that of mission functions bounded by MIW, system functions bounded by ECS, and IM&M initially unbounded. This region was subjected to a two dimensional ranking of mission versus system hierarchical weighted comparison of attributes. The resultant ranking of systems by

contribution to mission was then compared to another weighted hierarchy of IM&M attributes. The resulting comparison of IM&M functions contributing the most to system functions contributing the most to mission functions identifies IM&M techniques which may enhance NSSN C3IS design.

This analysis was conducted using spreadsheets of a unity based weighted hierarchy of mission functions populated by subjective scores of system performance within the mission functions. Examples of the model output for the ECS function are presented in Appendix B to this report.

Focus on NSSN ECS and MIW

The initial works of this SBIR produced a conceptual model cube containing over 100 million candidate cells of mission, system and information technology functions. The techniques of factor and cluster analysis can cope with large numbers of candidate data, as the numerical methods are basic array manipulations using simple logic comparitors or filters. The problem, however, is the time required for the subjective value assessment for so many candidate cells. The techniques of multidimensional scaling when applied to a 100 million candidate population become a formidable challenge for the tools envisioned for this SBIR. Rather than have the multidimensional scaling phase of this effort languish as the factor analysis plodded through the subjective value assessment of over 100 million cells, a focus within a distinct region of the model cube was necessary.

At about the same time as this realization of the scope of the model cube occurred, the submarine community became engaged in an exercise with mine warfare forces. This exercise Kernel Blitz presented a well timed opportunity to focus the model effort within the region of MIW and NSSN ECS, while allowing the information technology axis to go unbounded at the outset of this focusing effort. This opportunity presented itself in the following problem. Mine hunting units were exercising a new capability of Line Of Sight (LOS) UHF data communications among mine hunting, support and command units. Not only were they demonstrating a new channel of communication but they were also demonstrating requirements for new logical data structures to be sent through these new channels. In response to national strategic emphasis on littoral operations, it became imperative that the NSSN be able to share in these communication channels and exchange information in the new data formats.

This problem presented a solid motivation to examine a specific mission area, MIW for an emergent system requirement , ECS in the NSSN. The remaining task was left to multi-dimensional scaling analysis of this region of the model cube, to identify promising areas of information technology in addressing the new problem.

Findings and Conclusions

Based on the studies and analyses conducted during Phase I of the SBIR effort, the following findings and conclusions are presented:

- ◊ The interrelationships of missions, systems, and potentially beneficial IM&M technologies are numerous and complex, yet fathomable within the context of a model of the C3I System.
- ◊ Such a model can provide a dependable structure for multivariate analyses of functions within the NSSN C3I System.
- ◊ The scope of the NSSN C3IS model at the 5th level of function decomposition is too large for the selected analytical tools. Analysis must be conducted at the 4th level. Alternatively, selected regions of the model at 5th and more detailed levels must be focused, or bounded, for analysis.
- ◊ The preliminary quantitative methods of multivariate analyses show that implementation of information dissemination functions within the NSSN ECS may provide significant benefit to MIW (and by extrapolation to other) functions.
- ◊ The existence of, for example, the Fiber Optic Cable Plant (FOCP) as both a combat system element *and* an IM&M technology demonstrates an intuitive grasp and an explicit acknowledgment of the benefits of sharing IM&M technologies across traditional vertically-oriented combat systems.
- ◊ The likely emergence of other such "servers" to multiple "clients" in the combat system environment to meet specific and recurring (i.e., cross subsystem) functional requirements represents the emergence of a "horizontalizing" trend that could improve the availability, efficiency, and fusion of the information resource.
- ◊ With the advent of additional "servers" in the C3I System, common functional improvements to multiple vertical systems can be achieved at the cost of developing a single application vice deltas to each of the vertical systems.
- ◊ The C3IS hardware and software architectures should be updated and/or redesigned to include additional elements (e.g., NT hardware/software platform(s), Personal Digital Assistants, etc.) to offer development environment alternatives, as well as points for information collection and fusion that are external to existing system boundaries.
- ◊ Certain combat system boundaries (as currently drawn) are more "inertial" or "organizational" in nature than they are based on the uniqueness of the underlying information movement and management principles.
- ◊ Significantly different architectures alternatives would evolve from combat systems designed purely on IM&M principles (e.g., shared storage, processing servers, etc.).
- ◊ The emergence of a "link the way you think" philosophy suggests that providing mission critical information may require a reassessment of current information categorization schemes and boundaries (e.g., tactical vs. non-tactical data).

Areas for Further Investigation

Based on the findings of the Phase I SBIR project, a variety of opportunities are available to continue the research initiated during Phase I, namely to implement the concept of improving submarine combat capabilities through the exploitation of Information Movement and Management (IM&M) techniques within legacy and systems undergoing design development, i.e., the New Attack Submarine (NSSN) Command, Control, Communications and Intelligence System (C3IS). These proposed efforts would apply the optimum mix of IM&M capabilities found within the major divisions of the information life-cycle – information acquisition, storage, manipulation, distribution, presentation (man machine interface (MMI)), and archival, to the submarine systems most involved in C4I in emerging submarine mission areas. Specifically, the IM&M areas of information manipulation and distribution in the submarine C3IS and Exterior Communications System (ECS) subsystems that are engaged in littoral missions could be created in prototype and used to carry out the primary objective of developing the concept of virtual diagnostic devices based on intelligent brokers in complex systems. These intelligent brokers would be used to manipulate host information and distribute diagnostic signals among virtual diagnostic devices. These intelligent brokers would also support a secondary objective, creation of a mobile broker to allow meaningful, and dynamically changing, communications among multiple Personal Digital Assistants (PDA) and multiple hosts. The three distinct objectives of any subsequent efforts are discussed in this section of the SBIR Phase I Final Report.

Primary Objective: Develop Intelligent Brokers and Advance the Concept of Virtual Diagnostics

The primary objective of a follow-on to the Phase I effort would be to create a virtual diagnostic device based on an intelligent broker within the middleware domain of the attack submarine C3IS; with initial focus on the interface between the Command Subsystem and the Exterior Communications System (ECS). The intelligent broker would be implemented as software within the local area network (LAN) architecture and as hardware and software in the VME or other point-to-point bus architecture. The intelligent broker would have the capability to passively sample and store (or forward) selective data elements (or data fragments) within the host systems. The patterns used by the intelligent broker for data collection would be a combination of set patterns native to the local broker, dynamic patterns taken from a range of parameters, and new patterns broadcast from other brokers. The information collected by the brokers and the patterns broadcast among the brokers would be transmitted independent of the host networks, busses and point-to-point routes. This concept of an independent route for the development of virtual diagnostic devices is demonstrated in Figure 2.

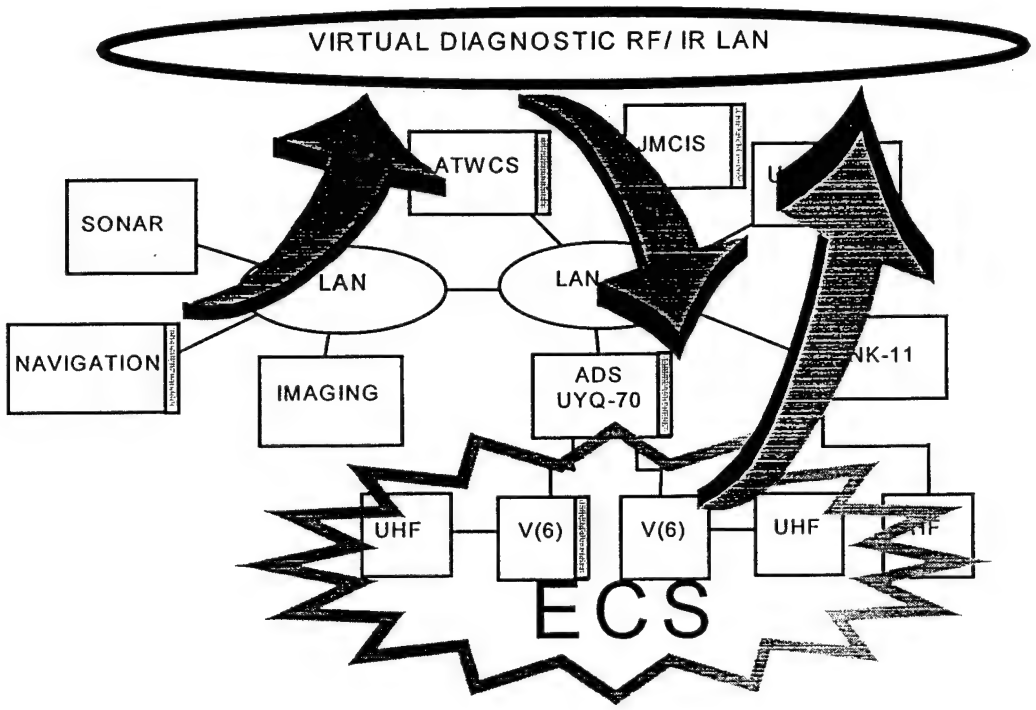


Figure 2: Intelligent Brokers Communicating Via Independent LAN

The development of intelligent brokers that can be inserted in existing systems, such as the ECS shown in the figure, capable of extracting data and assembling meaningful information without perturbing the existing equipment could be a major benefit to all Navy shipboard systems. As combat systems undergo revisions and upgrades, it is often difficult to make diagnostic and maintenance procedures that are seamless across the revised system. With today's emphasis on open architecture, a new capability inserted in an existing system often means the insertion of a new computing device, sometimes complete with its own diagnostics procedures. These new insertions usually don't address the problem of system-wide or intersystem diagnostics. Technicians and operators are faced with a new set of procedures for each new addition. Intelligent brokers will collect data from existing systems and new additions alike and create hybrid information that will accommodate system-wide and intersystem diagnostics.

Second Objective: Develop a Mobile Intelligent Broker

A second objective of follow-on work would be to create a mobile broker among the intelligent brokers, host systems and personal digital assistants (PDA) used by submarine watchstanders in control and radio. This broker could be implemented as software within the local area network architecture, as hardware and software in the bus

architecture, and as hardware and software in the PDA. The mobile broker would present the personality profile of the PDA (queries), which identifies the specific requirements of its owner, and would present the offerings of the intelligent brokers found within the C4I and ECS systems in response to these queries.

The concept of a mobile intelligent broker centers on the ability to interact with multiple remote sources; intelligent brokers residing in various systems, and thereby create new information and controls. This new information can be new hybrid form of data based on the separate sources or a composite of the various pieces of data collected. The controls within the mobile intelligent broker may be single purpose with a single target system; or may be decomposed to signal several systems simultaneously, or in a coordinated manner.

The mobile intelligent broker could be used as a design development tool to give a dynamic capability to identify requirements for information at discrete points within a new design. The mobile intelligent broker could assume the personality, meaning the nature of information requirements, of a specific subsystem; then interact with multiple intelligent brokers residing in other subsystems to test the feasibility of creating new nodes or paths for information within the new design.

In the NSSN design, the submarine Commanding Officer and Conning Officer are being provided a command subsystem work station to concentrate and present information and control functions for the command of the submarine systems. In the normal course of system design, the various information requirements among the subsystems will be identified and satisfied using multiple LANs and point-to-point routes. Once this design is complete and the system implemented in software and hardware, the creation of new data routes or modification of old routes will be an expensive process. A mobile intelligent broker would provide the means of feasibility testing of new requirements and methods before modifications were made to the existing design. Questions such as "What is the best source, or optimum route, of a particular piece of information?", or "If a new piece of information were available, would it be of use at a specific workstation?" could be answered without perturbing the existing design.

Third Objective: Develop a Method for Quantitative Specification of a Complex System

A byproduct of a follow-on SBIR effort would be a structured method of conducting system analysis and creating a useable logical model of the information residing in or transiting complex information systems. This method would comprise existing computer aided software engineering (CASE) tools linked together in an increasingly complex analysis and then synthesis of the information in a system. These tools would be compatible with other ongoing data analysis efforts within the Navy, Defense Information Systems Agency (DISA) and industry.

Appendix A
Multidimensional Array for Navigation Function
(RLGN and GPS)

Multidimensional Array for NSSN SBIR Phase I

RLGN			ASW					
			Search					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisitio	Sense	Active	330	330	110	330	110	110
		Passive	333	333	333	333	333	223
	Communi	Query	110	110	110	110	110	110
		Broadcast	333	333	000	000	000	000
Storage	Physical	Memory	333	333	113	113	113	113
		Static	333	333	113	113	113	113
		Mass	333	333	113	113	113	113
	Logical	Address	333	333	113	113	113	113
		Array	222	222	112	112	112	112
		File	222	222	112	112	112	112
		FMS	222	222	112	112	112	112
		DBMS	222	222	112	112	112	112
Manipulati	Analyze	Compute	333	333	113	113	113	113
		Compare	222	222	112	112	112	112
	Transact	Add	222	222	112	112	112	112
		Delete	222	222	112	112	112	112
		Change	222	222	112	112	112	112
Distributio	Broadcast	Multi-poin	331	331	111	111	111	111
		Point	331	331	111	111	111	111
	Discreet	Response	222	222	112	112	112	112
		Process	222	222	112	112	112	112
MMI	Present	Visual	113	113	003	003	003	003
		Aural	110	110	000	000	000	000
		Tactile	000	000	000	000	000	000
	Control	System	333	333	113	113	113	113
		Functions	333	333	113	113	113	113
		Applicatio	333	333	113	113	113	113
Maintena	Update	Audit	222	222	112	112	112	112
		Compare	222	222	112	112	112	112
		Restore	222	222	112	112	112	112
	Archive	Working	222	222	112	112	112	112
		Historic	222	222	112	112	112	112
	Destroy	Dynamic	222	222	112	112	112	112
		Cleansing	222	222	112	112	112	112

Multidimensional Array for NSSN SBIR Phase I

RLGN								
			Localize					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisitio	Sense	Active	330	330	330	330	110	110
		Passive	333	333	333	333	333	223
	Communi	Query	110	110	110	110	110	110
		Broadcast	333	333	000	000	000	000
Storage	Physical	Memory	333	333	113	113	113	113
		Static	333	333	113	113	113	113
		Mass	333	333	113	113	113	113
	Logical	Address	333	333	113	113	113	113
		Array	222	222	112	112	112	112
		File	222	222	112	112	112	112
		FMS	222	222	112	112	112	112
		DBMS	222	222	112	112	112	112
Manipulati	Analyze	Compute	333	333	113	113	113	113
		Compare	222	222	112	112	112	112
	Transact	Add	222	222	112	112	112	112
		Delete	222	222	112	112	112	112
		Change	222	222	112	112	112	112
Distributio	Broadcast	Multi-poin	331	331	111	111	111	111
		Point	331	331	111	111	111	111
	Discreet	Response	222	222	112	112	112	112
		Process	222	222	112	112	112	112
MMI	Present	Visual	113	113	003	003	003	003
		Aural	110	110	000	000	000	000
		Tactile	000	000	000	000	000	000
	Control	System	333	333	113	113	113	113
		Functions	333	333	113	113	113	113
		Applicatio	333	333	113	113	113	113
Maintena	Update	Audit	222	222	112	112	112	112
		Compare	222	222	112	112	112	112
		Restore	222	222	112	112	112	112
	Archive	Working	222	222	112	112	112	112
		Historic	222	222	112	112	112	112
	Destroy	Dynamic	222	222	112	112	112	112
		Cleansing	222	222	112	112	112	112

Multidimensional Array for NSSN SBIR Phase I

RLGN								
			Detect					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisitio	Sense	Active	330	330	330	330	110	110
		Passive	333	333	333	333	333	223
	Communi	Query	110	110	110	110	110	110
		Broadcast	333	333	000	000	000	000
Storage	Physical	Memory	333	333	113	113	113	113
		Static	333	333	113	113	113	113
		Mass	333	333	113	113	113	113
	Logical	Address	333	333	113	113	113	113
		Array	222	222	112	112	112	112
		File	222	222	112	112	112	112
		FMS	222	222	112	112	112	112
		DBMS	222	222	112	112	112	112
Manipulati	Analyze	Compute	333	333	113	113	113	113
		Compare	222	222	112	112	112	112
	Transact	Add	222	222	112	112	112	112
		Delete	222	222	112	112	112	112
		Change	222	222	112	112	112	112
Distributio	Broadcast	Multi-poin	331	331	111	111	111	111
		Point	331	331	111	111	111	111
	Discreet	Response	222	222	112	112	112	112
		Process	222	222	112	112	112	112
MMI	Present	Visual	113	113	003	003	003	003
		Aural	110	110	000	000	000	000
		Tactile	000	000	000	000	000	000
	Control	System	333	333	113	113	113	113
		Functions	333	333	113	113	113	113
		Applicatio	333	333	113	113	113	113
Maintena	Update	Audit	222	222	112	112	112	112
		Compare	222	222	112	112	112	112
		Restore	222	222	112	112	112	112
	Archive	Working	222	222	112	112	112	112
		Historic	222	222	112	112	112	112
	Destroy	Dynamic	222	222	112	112	112	112
		Cleansing	222	222	112	112	112	112

Multidimensional Array for NSSN SBIR Phase I

RLGN								
			Engage					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisitio	Sense	Active	330	330	330	330	110	110
		Passive	333	333	333	333	333	223
	Communi	Query	110	110	110	110	110	110
		Broadcast	333	333	000	000	000	000
Storage	Physical	Memory	333	333	113	113	113	113
		Static	333	333	113	113	113	113
		Mass	333	333	113	113	113	113
	Logical	Address	333	333	113	113	113	113
		Array	222	222	112	112	112	112
		File	222	222	112	112	112	112
		FMS	222	222	112	112	112	112
		DBMS	222	222	112	112	112	112
Manipulati	Analyze	Compute	333	333	113	113	113	113
		Compare	222	222	112	112	112	112
	Transact	Add	222	222	112	112	112	112
		Delete	222	222	112	112	112	112
		Change	222	222	112	112	112	112
Distributio	Broadcast	Multi-poin	331	331	111	111	111	111
		Point	331	331	111	111	111	111
	Discreet	Response	222	222	112	112	112	112
		Process	222	222	112	112	112	112
MMI	Present	Visual	113	113	003	003	003	003
		Aural	110	110	000	000	000	000
		Tactile	000	000	000	000	000	000
	Control	System	333	333	113	113	113	113
		Functions	333	333	113	113	113	113
		Applicatio	333	333	113	113	113	113
Maintena	Update	Audit	222	222	112	112	112	112
		Compare	222	222	112	112	112	112
		Restore	222	222	112	112	112	112
	Archive	Working	222	222	112	112	112	112
		Historic	222	222	112	112	112	112
	Destroy	Dynamic	222	222	112	112	112	112
		Cleansing	222	222	112	112	112	112

Multidimensional Array for NSSN SBIR Phase I

RLGN								
			Assess					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisitio	Sense	Active	330	330	330	330	110	110
		Passive	333	333	333	333	333	223
	Communi	Query	110	110	110	110	110	110
		Broadcast	333	333	000	000	000	000
Storage	Physical	Memory	333	333	113	113	113	113
		Static	333	333	113	113	113	113
		Mass	333	333	113	113	113	113
	Logical	Address	333	333	113	113	113	113
		Array	222	222	112	112	112	112
		File	222	222	112	112	112	112
		FMS	222	222	112	112	112	112
		DBMS	222	222	112	112	112	112
Manipulati	Analyze	Compute	333	333	113	113	113	113
		Compare	222	222	112	112	112	112
	Transact	Add	222	222	112	112	112	112
		Delete	222	222	112	112	112	112
		Change	222	222	112	112	112	112
Distributio	Broadcast	Multi-poin	331	331	111	111	111	111
		Point	331	331	111	111	111	111
	Discreet	Response	222	222	112	112	112	112
		Process	222	222	112	112	112	112
MMI	Present	Visual	113	113	003	003	003	003
		Aural	110	110	000	000	000	000
		Tactile	000	000	000	000	000	000
	Control	System	333	333	113	113	113	113
		Functions	333	333	113	113	113	113
		Applicatio	333	333	113	113	113	113
Maintena	Update	Audit	222	222	112	112	112	112
		Compare	222	222	112	112	112	112
		Restore	222	222	112	112	112	112
	Archive	Working	222	222	112	112	112	112
		Historic	222	222	112	112	112	112
	Destroy	Dynamic	222	222	112	112	112	112
		Cleansing	222	222	112	112	112	112

Multidimensional Array for NSSN SBIR Phase I

RLGN			MIW					
			Mining					
			Orient	Maneuver	Sensor	Deploy	Determin	Relate
Acquisitio	Sense	Active	110	110	110	110	110	110
		Passive	333	333	333	333	333	333
	Communi	Query	110	000	110	000	110	220
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	333	333	333	333	333	333
		Static	333	333	333	333	333	333
		Mass	111	111	111	111	111	111
	Logical	Address	333	333	333	333	333	333
		Array	222	222	222	222	222	222
		File	110	110	110	110	110	110
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulati	Analyze	Compute	333	333	333	333	333	333
		Compare	111	111	111	111	111	111
	Transact	Add	111	111	111	111	111	111
		Delete	111	111	111	111	111	111
		Change	111	111	111	111	111	111
Distributio	Broadcast	Multi-poin	330	330	330	330	330	330
		Point	333	333	333	333	333	333
	Discreet	Response	222	222	112	112	112	112
		Process	222	222	112	112	112	112
MMI	Present	Visual	113	113	003	003	003	003
		Aural	110	110	000	000	000	000
		Tactile	000	000	000	000	000	000
	Control	System	333	333	333	333	333	333
		Functions	333	333	333	333	333	333
		Applicatio	333	333	333	333	333	333
Maintena	Update	Audit	112	112	112	112	112	112
		Compare	112	112	112	112	112	112
		Restore	112	112	112	112	112	112
	Archive	Working	112	112	112	112	112	112
		Historic	112	112	112	112	112	112
	Destroy	Dynamic	112	112	112	112	112	112
		Cleansing	112	112	112	112	112	112

Multidimensional Array for NSSN SBIR Phase I

RLGN								
			MCM					
			Search					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisitio	Sense	Active	110	110	110	110	110	110
		Passive	333	333	333	333	333	333
	Communi	Query	110	000	110	000	110	220
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	333	333	333	333	333	333
		Static	333	333	333	333	333	333
		Mass	111	111	111	111	111	111
	Logical	Address	333	333	333	333	333	333
		Array	222	222	222	222	222	222
		File	110	110	110	110	110	110
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulati	Analyze	Compute	333	333	333	333	333	333
		Compare	111	111	111	111	111	111
	Transact	Add	111	111	111	111	111	111
		Delete	111	111	111	111	111	111
		Change	111	111	111	111	111	111
Distributio	Broadcast	Multi-poin	330	330	330	330	330	330
		Point	333	333	333	333	333	333
	Discreet	Response	222	222	112	112	112	112
		Process	222	222	112	112	112	112
MMI	Present	Visual	113	113	003	003	003	003
		Aural	110	110	000	000	000	000
		Tactile	000	000	000	000	000	000
	Control	System	333	333	333	333	333	333
		Functions	333	333	333	333	333	333
		Applicatio	333	333	333	333	333	333
Maintena	Update	Audit	112	112	112	112	112	112
		Compare	112	112	112	112	112	112
		Restore	112	112	112	112	112	112
	Archive	Working	112	112	112	112	112	112
		Historic	112	112	112	112	112	112
	Destroy	Dynamic	112	112	112	112	112	112
		Cleansing	112	112	112	112	112	112

Multidimensional Array for NSSN SBIR Phase I

RLGN								
			Localize					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisitio	Sense	Active	110	110	110	110	110	110
		Passive	333	333	333	333	333	333
	Communi	Query	110	000	110	000	110	220
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	333	333	333	333	333	333
		Static	333	333	333	333	333	333
		Mass	111	111	111	111	111	111
	Logical	Address	333	333	333	333	333	333
		Array	222	222	222	222	222	222
		File	110	110	110	110	110	110
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulati	Analyze	Compute	333	333	333	333	333	333
		Compare	111	111	111	111	111	111
	Transact	Add	111	111	111	111	111	111
		Delete	111	111	111	111	111	111
		Change	111	111	111	111	111	111
Distributio	Broadcast	Multi-poin	330	330	330	330	330	330
		Point	333	333	333	333	333	333
	Discreet	Response	222	222	112	112	112	112
		Process	222	222	112	112	112	112
MMI	Present	Visual	113	113	003	003	003	003
		Aural	110	110	000	000	000	000
		Tactile	000	000	000	000	000	000
	Control	System	333	333	333	333	333	333
		Functions	333	333	333	333	333	333
		Applicatio	333	333	333	333	333	333
Maintena	Update	Audit	112	112	112	112	112	112
		Compare	112	112	112	112	112	112
		Restore	112	112	112	112	112	112
	Archive	Working	112	112	112	112	112	112
		Historic	112	112	112	112	112	112
	Destroy	Dynamic	112	112	112	112	112	112
		Cleansing	112	112	112	112	112	112

Multidimensional Array for NSSN SBIR Phase I

RLGN								
			Detect					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisitio	Sense	Active	110	110	110	110	110	110
		Passive	333	333	333	333	333	333
	Communi	Query	110	000	110	000	110	220
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	333	333	333	333	333	333
		Static	333	333	333	333	333	333
		Mass	111	111	111	111	111	111
	Logical	Address	333	333	333	333	333	333
		Array	222	222	222	222	222	222
		File	110	110	110	110	110	110
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulati	Analyze	Compute	333	333	333	333	333	333
		Compare	111	111	111	111	111	111
	Transact	Add	111	111	111	111	111	111
		Delete	111	111	111	111	111	111
		Change	111	111	111	111	111	111
Distributio	Broadcast	Multi-poin	330	330	330	330	330	330
		Point	333	333	333	333	333	333
	Discreet	Response	222	222	112	112	112	112
		Process	222	222	112	112	112	112
MMI	Present	Visual	113	113	003	003	003	003
		Aural	110	110	000	000	000	000
		Tactile	000	000	000	000	000	000
	Control	System	333	333	333	333	333	333
		Functions	333	333	333	333	333	333
		Applicatio	333	333	333	333	333	333
Maintena	Update	Audit	112	112	112	112	112	112
		Compare	112	112	112	112	112	112
		Restore	112	112	112	112	112	112
	Archive	Working	112	112	112	112	112	112
		Historic	112	112	112	112	112	112
	Destroy	Dynamic	112	112	112	112	112	112
		Cleansing	112	112	112	112	112	112

Multidimensional Array for NSSN SBIR Phase I

RLGN								
			Engage					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisitio	Sense	Active	110	110	110	110	110	110
		Passive	333	333	333	333	333	333
	Communi	Query	110	000	110	000	110	220
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	333	333	333	333	333	333
		Static	333	333	333	333	333	333
		Mass	111	111	111	111	111	111
	Logical	Address	333	333	333	333	333	333
		Array	222	222	222	222	222	222
		File	110	110	110	110	110	110
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulati	Analyze	Compute	333	333	333	333	333	333
		Compare	111	111	111	111	111	111
	Transact	Add	111	111	111	111	111	111
		Delete	111	111	111	111	111	111
		Change	111	111	111	111	111	111
Distributio	Broadcast	Multi-poin	330	330	330	330	330	330
		Point	333	333	333	333	333	333
	Discreet	Response	222	222	112	112	112	112
		Process	222	222	112	112	112	112
MMI	Present	Visual	113	113	003	003	003	003
		Aural	110	110	000	000	000	000
		Tactile	000	000	000	000	000	000
	Control	System	333	333	333	333	333	333
		Functions	333	333	333	333	333	333
		Applicatio	333	333	333	333	333	333
Maintena	Update	Audit	112	112	112	112	112	112
		Compare	112	112	112	112	112	112
		Restore	112	112	112	112	112	112
	Archive	Working	112	112	112	112	112	112
		Historic	112	112	112	112	112	112
	Destroy	Dynamic	112	112	112	112	112	112
		Cleansing	112	112	112	112	112	112

Multidimensional Array for NSSN SBIR Phase I

RLGN								
			Assess					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisitio	Sense	Active	110	110	110	110	110	110
		Passive	333	333	333	333	333	333
	Communi	Query	110	000	110	000	110	220
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	333	333	333	333	333	333
		Static	333	333	333	333	333	333
		Mass	111	111	111	111	111	111
	Logical	Address	333	333	333	333	333	333
		Array	222	222	222	222	222	222
		File	110	110	110	110	110	110
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulati	Analyze	Compute	333	333	333	333	333	333
		Compare	111	111	111	111	111	111
	Transact	Add	111	111	111	111	111	111
		Delete	111	111	111	111	111	111
		Change	111	111	111	111	111	111
Distributio	Broadcast	Multi-poin	330	330	330	330	330	330
		Point	333	333	333	333	333	333
	Discreet	Response	222	222	112	112	112	112
		Process	222	222	112	112	112	112
MMI	Present	Visual	113	113	003	003	003	003
		Aural	110	110	000	000	000	000
		Tactile	000	000	000	000	000	000
	Control	System	333	333	333	333	333	333
		Functions	333	333	333	333	333	333
		Applicatio	333	333	333	333	333	333
Maintena	Update	Audit	112	112	112	112	112	112
		Compare	112	112	112	112	112	112
		Restore	112	112	112	112	112	112
	Archive	Working	112	112	112	112	112	112
		Historic	112	112	112	112	112	112
	Destroy	Dynamic	112	112	112	112	112	112
		Cleansing	112	112	112	112	112	112

Multidimensional Array for NSSN SBIR Phase I

GPS			ASW					
			Search					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisitio	Sense	Active	333	333	113	333	113	113
		Passive	330	330	330	330	330	220
	Communi	Query	110	110	110	110	110	110
		Broadcast	333	333	000	000	000	000
Storage	Physical	Memory	333	333	113	113	113	113
		Static	333	333	113	113	113	113
		Mass	333	333	113	113	113	113
	Logical	Address	333	333	113	113	113	113
		Array	222	222	112	112	112	112
		File	222	222	112	112	112	112
		FMS	222	222	112	112	112	112
		DBMS	222	222	112	112	112	112
Manipulati	Analyze	Compute	333	333	113	113	113	113
		Compare	222	222	112	112	112	112
	Transact	Add	222	222	112	112	112	112
		Delete	222	222	112	112	112	112
		Change	222	222	112	112	112	112
Distributio	Broadcast	Multi-poin	331	331	111	111	111	111
		Point	331	331	111	111	111	111
	Discreet	Response	222	222	112	112	112	112
		Process	222	222	112	112	112	112
MMI	Present	Visual	113	113	003	003	003	003
		Aural	110	110	000	000	000	000
		Tactile	000	000	000	000	000	000
	Control	System	333	333	113	113	113	113
		Functions	333	333	113	113	113	113
		Applicatio	333	333	113	113	113	113
Maintena	Update	Audit	222	222	112	112	112	112
		Compare	222	222	112	112	112	112
		Restore	222	222	112	112	112	112
	Archive	Working	222	222	112	112	112	112
		Historic	222	222	112	112	112	112
	Destroy	Dynamic	222	222	112	112	112	112
		Cleansing	222	222	112	112	112	112

Multidimensional Array for NSSN SBIR Phase I

Localize						Detect		
Orient	Maneuver	Sensor	Determin	Define	Relate	Orient	Maneuver	Sensor
330	330	330	330	110	110	330	330	330
330	330	330	330	330	220	330	330	330
110	110	110	110	110	110	110	110	110
333	333	000	000	000	000	333	333	000
333	333	113	113	113	113	333	333	113
333	333	113	113	113	113	333	333	113
333	333	113	113	113	113	333	333	113
333	333	113	113	113	113	333	333	113
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
333	333	113	113	113	113	333	333	113
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
331	331	111	111	111	111	331	331	111
331	331	111	111	111	111	331	331	111
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
113	113	003	003	003	003	113	113	003
110	110	000	000	000	000	110	110	000
000	000	000	000	000	000	000	000	000
333	333	113	113	113	113	333	333	113
333	333	113	113	113	113	333	333	113
333	333	113	113	113	113	333	333	113
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112

Multidimensional Array for NSSN SBIR Phase I

			Engage					
Determin	Define	Relate	Orient	Maneuver	Sensor	Determin	Define	Relate
330	110	110	330	330	330	330	110	110
330	330	220	330	330	330	330	330	220
110	110	110	110	110	110	110	110	110
000	000	000	333	333	000	000	000	000
113	113	113	333	333	113	113	113	113
113	113	113	333	333	113	113	113	113
113	113	113	333	333	113	113	113	113
113	113	113	333	333	113	113	113	113
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
113	113	113	333	333	113	113	113	113
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
111	111	111	331	331	111	111	111	111
111	111	111	331	331	111	111	111	111
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
003	003	003	113	113	003	003	003	003
000	000	000	110	110	000	000	000	000
000	000	000	000	000	000	000	000	000
113	113	113	333	333	113	113	113	113
113	113	113	333	333	113	113	113	113
113	113	113	333	333	113	113	113	113
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112

Multidimensional Array for NSSN SBIR Phase I

						MIW Mining		
Assess								
Orient	Maneuver	Sensor	Determin	Define	Relate	Orient	Maneuver	Sensor
330	330	330	330	110	110	110	110	110
330	330	330	330	330	220	333	330	330
110	110	110	110	110	110	110	000	110
333	333	000	000	000	000	333	330	330
333	333	113	113	113	113	333	333	113
333	333	113	113	113	113	333	333	113
333	333	113	113	113	113	333	333	113
333	333	113	113	113	113	333	333	113
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
333	333	113	113	113	113	333	333	113
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
331	331	111	111	111	111	331	331	111
331	331	111	111	111	111	331	331	111
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
113	113	003	003	003	003	113	113	003
110	110	000	000	000	000	110	110	000
000	000	000	000	000	000	000	000	000
333	333	113	113	113	113	333	333	113
333	333	113	113	113	113	333	333	113
333	333	113	113	113	113	333	333	113
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112

Multidimensional Array for NSSN SBIR Phase I

			MCM					
			Search					
Deploy	Determin	Relate	Orient	Maneuver	Sensor	Determin	Define	Relate
110	110	110	330	330	330	330	330	330
330	330	331	333	330	330	330	330	330
000	110	220	110	000	000	000	000	000
330	330	330	333	330	330	330	330	330
113	113	113	333	223	223	223	223	223
113	113	113	333	223	223	223	223	223
113	113	113	220	220	220	220	220	220
113	113	113	333	333	113	113	113	113
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
113	113	113	333	333	113	113	113	113
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
111	111	111	331	331	111	111	111	111
111	111	111	331	331	111	111	111	111
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
003	003	003	113	113	003	003	003	003
000	000	000	110	110	000	000	000	000
000	000	000	000	000	000	000	000	000
113	113	113	333	333	113	113	113	113
113	113	113	333	333	113	113	113	113
113	113	113	333	333	113	113	113	113
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112

Multidimensional Array for NSSN SBIR Phase I

Localize						Detect		
Orient	Maneuver	Sensor	Determin	Define	Relate	Orient	Maneuver	Sensor
330	330	330	330	330	330	330	330	330
330	330	330	330	330	330	330	330	330
110	000	000	000	000	000	110	000	000
330	330	330	330	330	330	330	330	330
333	223	223	223	223	223	333	223	223
333	223	223	223	223	223	333	223	223
220	220	220	220	220	220	220	220	220
333	333	113	113	113	113	333	333	113
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
333	333	113	113	113	113	333	333	113
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
331	331	111	111	111	111	331	331	111
331	331	111	111	111	111	331	331	111
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
113	113	003	003	003	003	113	113	003
110	110	000	000	000	000	110	110	000
000	000	000	000	000	000	000	000	000
333	333	113	113	113	113	333	333	113
333	333	113	113	113	113	333	333	113
333	333	113	113	113	113	333	333	113
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112
222	222	112	112	112	112	222	222	112

Multidimensional Array for NSSN SBIR Phase I

			Engage					
Determin	Define	Relate	Orient	Maneuver	Sensor	Determin	Define	Relate
330	330	330	330	330	330	330	330	330
330	330	330	330	330	330	330	330	330
000	000	000	110	000	000	000	000	000
330	330	330	330	330	330	330	330	330
223	223	223	333	223	223	223	223	223
223	223	223	333	223	223	223	223	223
220	220	220	220	220	220	220	220	220
113	113	113	333	333	113	113	113	113
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
113	113	113	333	333	113	113	113	113
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
111	111	111	331	331	111	111	111	111
111	111	111	331	331	111	111	111	111
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
003	003	003	113	113	003	003	003	003
000	000	000	110	110	000	000	000	000
000	000	000	000	000	000	000	000	000
113	113	113	333	333	113	113	113	113
113	113	113	333	333	113	113	113	113
113	113	113	333	333	113	113	113	113
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112
112	112	112	222	222	112	112	112	112

Multidimensional Array for NSSN SBIR Phase I

						STW	IW	SOW
Assess								
Orient	Maneuver	Sensor	Determin	Define	Relate			
330	330	330	330	330	330			
330	330	330	330	330	330			
110	000	000	000	000	000			
330	330	330	330	330	330			
333	223	223	223	223	223			
333	223	223	223	223	223			
220	220	220	220	220	220			
333	333	113	113	113	113			
222	222	112	112	112	112			
222	222	112	112	112	112			
222	222	112	112	112	112			
222	222	112	112	112	112			
333	333	113	113	113	113			
222	222	112	112	112	112			
222	222	112	112	112	112			
222	222	112	112	112	112			
222	222	112	112	112	112			
331	331	111	111	111	111			
331	331	111	111	111	111			
222	222	112	112	112	112			
222	222	112	112	112	112			
113	113	003	003	003	003			
110	110	000	000	000	000			
000	000	000	000	000	000			
333	333	113	113	113	113			
333	333	113	113	113	113			
333	333	113	113	113	113			
222	222	112	112	112	112			
222	222	112	112	112	112			
222	222	112	112	112	112			
222	222	112	112	112	112			
222	222	112	112	112	112			
222	222	112	112	112	112			
222	222	112	112	112	112			

Appendix B
Multidimensional Array for Communication Function and MIW Mission Area

Multidimensional Array for NSSN SBIR Phase I

Voice Comms			ASW				
			Search				
			Orient	Maneuver	Sensor	Determine	Define
Acquisition	Sense	Active	112	112	112	212	212
		Passive	132	132	132	232	232
	Communicate	Query	113	133	133	233	233
		Broadcast	103	133	133	233	233
Storage	Physical	Memory	100	100	100	200	200
		Static	100	100	100	200	200
		Mass	100	100	100	200	200
	Logical	Address	100	100	100	200	200
		Array	100	100	100	200	200
		File	100	100	100	200	200
		FMS	100	100	100	200	200
		DBMS	100	100	100	200	200
Manipulation	Analyze	Compute	100	100	100	200	200
		Compare	100	100	100	200	200
	Transact	Add	100	100	100	200	200
		Delete	100	100	100	200	200
		Change	100	100	100	200	200
Distribution	Broadcast	Multi-point	122	133	122	222	222
		Point	122	133	122	222	222
	Discreet	Response	122	133	122	222	222
		Process	122	133	122	222	222
MMI	Present	Visual	111	111	111	211	211
		Aural	133	133	133	233	233
		Tactile	111	111	111	211	211
	Control	System	111	111	111	211	211
		Functions	131	133	132	232	232
		Application	131	133	132	232	232
Maintenance	Update	Audit	100	100	100	200	200
		Compare	100	100	100	200	200
		Restore	100	100	100	200	200
	Archive	Working	100	100	100	200	200
		Historic	100	100	100	200	200
	Destroy	Dynamic	100	100	100	200	200
		Cleansing	100	100	100	200	200

Multidimensional Array for NSSN SBIR Phase I

Voice Comms							
				Localize			
			Relate	Orient	Maneuver	Sensor	Determin
Acquisition	Sense	Active	112	112	112	112	212
		Passive	132	132	132	132	232
	Communicate	Query	113	113	133	133	233
		Broadcast	103	103	133	133	233
Storage	Physical	Memory	100	100	100	100	200
		Static	100	100	100	100	200
		Mass	100	100	100	100	200
	Logical	Address	100	100	100	100	200
		Array	100	100	100	100	200
		File	100	100	100	100	200
		FMS	100	100	100	100	200
		DBMS	100	100	100	100	200
Manipulation	Analyze	Compute	100	100	100	100	200
		Compare	100	100	100	100	200
	Transact	Add	100	100	100	100	200
		Delete	100	100	100	100	200
		Change	100	100	100	100	200
Distribution	Broadcast	Multi-point	122	122	133	122	222
		Point	122	122	133	122	222
	Discreet	Response	122	122	133	122	222
		Process	122	122	133	122	222
MMI	Present	Visual	111	111	111	111	211
		Aural	133	133	133	133	233
		Tactile	111	111	111	111	211
	Control	System	111	111	111	111	211
		Functions	131	131	133	132	232
		Application	131	131	133	132	232
Maintenance	Update	Audit	100	100	100	100	200
		Compare	100	100	100	100	200
		Restore	100	100	100	100	200
	Archive	Working	100	100	100	100	200
		Historic	100	100	100	100	200
	Destroy	Dynamic	100	100	100	100	200
		Cleansing	100	100	100	100	200

Multidimensional Array for NSSN SBIR Phase I

Voice Comms				
			Define	Relate
Acquisition	Sense	Active	212	112
		Passive	232	132
	Communicate	Query	233	113
		Broadcast	233	103
Storage	Physical	Memory	200	100
		Static	200	100
		Mass	200	100
	Logical	Address	200	100
		Array	200	100
		File	200	100
		FMS	200	100
		DBMS	200	100
Manipulation	Analyze	Compute	200	100
		Compare	200	100
	Transact	Add	200	100
		Delete	200	100
		Change	200	100
Distribution	Broadcast	Multi-point	222	122
		Point	222	122
	Discreet	Response	222	122
		Process	222	122
MMI	Present	Visual	211	111
		Aural	233	133
		Tactile	211	111
	Control	System	211	111
		Functions	232	131
		Application	232	131
Maintenance	Update	Audit	200	100
		Compare	200	100
		Restore	200	100
	Archive	Working	200	100
		Historic	200	100
	Destroy	Dynamic	200	100
		Cleansing	200	100

Multidimensional Array for NSSN SBIR Phase I

AN/WSC-3			MIW					
			Mining					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	333	330	330	330	330	330
		Passive	333	330	330	330	330	330
	Communi	Query	333	330	330	330	330	330
		Broadcast	333	330	330	330	330	330
Storage	Physical	Memory	221	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	222	220	220	220	220	220
		Array	111	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	111	110	110	110	110	110
		Compare	111	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	000	220	220	220	220	220
		Point	222	220	220	220	220	220
	Discreet	Response	222	220	220	220	220	220
		Process	222	220	220	220	220	220
MMI	Present	Visual	222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

AN/WSC-3								
			MCM					
			Search					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	333	330	330	330	330	330
		Passive	333	330	330	330	330	330
	Communi	Query	333	330	330	330	330	330
		Broadcast	333	330	330	330	330	330
Storage	Physical	Memory	221	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	222	220	220	220	220	220
		Array	111	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	111	110	110	110	110	110
		Compare	111	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	000	220	220	220	220	220
		Point	222	220	220	220	220	220
	Discreet	Response	222	220	220	220	220	220
		Process	222	220	220	220	220	220
MMI	Present	Visual	222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing						000
			000	000	000	000	000	

Multidimensional Array for NSSN SBIR Phase I

AN/WSC-3								
			Localize					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

AN/WSC-3								
			Detect					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

AN/WSC-3								
			Engage					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

AN/WSC-3								
			Assess					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

ON-143(V)6			MIW					
			Mining					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	333	330	330	330	330	330
		Passive	333	330	330	330	330	330
	Communi	Query	333	330	330	330	330	330
		Broadcast	333	330	000	000	000	000
Storage	Physical	Memory	221	220	000	000	000	000
		Static	220	220	000	000	000	000
		Mass	110	110	000	333	333	333
	Logical	Address	222	220	000	333	333	333
		Array	111	110	000	333	333	333
		File	000	000	000	333	333	333
		FMS	000	000	000	333	333	333
		DBMS	000	000	000	333	333	333
Manipulation	Analyze	Compute	111	110	000	333	333	333
		Compare	111	110	000	333	333	333
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	000	220	220	220	220	220
		Point	222	220	220	220	220	220
	Discreet	Response	222	220	220	220	220	220
		Process	222	220	220	220	220	220
MMI	Present	Visual	222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

ON-143(V)6								
			MCM					
			Search					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	333	330	330	330	330	330
		Passive	333	330	330	330	330	330
	Communi	Query	333	330	330	330	330	330
		Broadcast	000	330	330	330	330	330
Storage	Physical	Memory	000	220	220	220	220	220
		Static	000	220	220	220	220	220
		Mass	000	110	110	110	110	110
	Logical	Address	000	220	220	220	220	220
		Array	000	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	000	110	110	110	110	110
		Compare	000	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	000	220	220	220	220	220
		Point	222	220	220	220	220	220
	Discreet	Response	222	220	220	220	220	220
		Process	222	220	220	220	220	220
MMI	Present	Visual	222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing						000

Multidimensional Array for NSSN SBIR Phase I

ON-143(V)6								
			Localize					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

ON-143(V)6								
			Detect					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

ON-143(V)6								
			Engage					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

ON-143(V)6								
			Assess					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

GFCP			MIW					
			Mining					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	333	333	330	330	330	330
		Passive	333	333	330	330	330	330
	Communi	Query	333	333	330	330	330	330
		Broadcast	333	333	000	000	000	000
Storage	Physical	Memory	333	333	000	000	000	000
		Static	333	333	000	000	000	000
		Mass	333	333	000	333	333	333
	Logical	Address	333	333	000	333	333	333
		Array	333	333	000	333	333	333
		File	333	333	000	333	333	333
		FMS	333	333	000	333	333	333
		DBMS	333	333	000	333	333	333
Manipulation	Analyze	Compute	111	110	000	333	333	333
		Compare	111	110	000	333	333	333
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	000	220	220	220	220	220
		Point	222	220	220	220	220	220
	Discreet	Response	222	220	220	220	220	220
		Process	222	220	220	220	220	220
MMI	Present	Visual	222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	333	333	222	222	222	222
	Control	System	333	333	222	222	222	222
		Functions	333	333	222	222	222	222
		Applicatio	333	333	222	222	222	222
Maintenance	Update	Audit	333	333	333	333	333	333
		Compare	333	333	333	333	333	333
		Restore	333	333	333	333	333	333
	Archive	Working	333	333	333	333	333	333
		Historic	333	333	333	333	333	333
	Destroy	Dynamic	333	333	333	333	333	333
		Cleansing	333	333	333	333	333	333

Multidimensional Array for NSSN SBIR Phase I

GFCP								
			MCM					
			Search					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	333	330	330	330	330	330
		Passive	333	330	330	330	330	330
	Communi	Query	333	330	330	330	330	330
		Broadcast	000	330	330	330	330	330
Storage	Physical	Memory	000	220	220	220	220	220
		Static	000	220	220	220	220	220
		Mass	000	110	110	110	110	110
	Logical	Address	000	220	220	220	220	220
		Array	000	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	000	110	110	110	110	110
		Compare	000	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	000	220	220	220	220	220
		Point	222	220	220	220	220	220
	Discreet	Response	222	220	220	220	220	220
		Process	222	220	220	220	220	220
MMI	Present	Visual	222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	333	333	333	333	333	333
		Compare	333	333	333	333	333	333
		Restore	333	333	333	333	333	333
	Archive	Working	333	333	333	333	333	333
		Historic	333	333	333	333	333	333
	Destroy	Dynamic	333	333	333	333	333	333
		Cleansing	333	333	333	333	333	333

Multidimensional Array for NSSN SBIR Phase I

GFCP								
			Localize					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	333	333	333	333	333	333
		Compare	333	333	333	333	333	333
		Restore	333	333	333	333	333	333
	Archive	Working	333	333	333	333	333	333
		Historic	333	333	333	333	333	333
	Destroy	Dynamic	333	333	333	333	333	333
		Cleansing	333	333	333	333	333	333

Multidimensional Array for NSSN SBIR Phase I

GFCP								
			Detect					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	333	333	333	333	333	333
		Compare	333	333	333	333	333	333
		Restore	333	333	333	333	333	333
	Archive	Working	333	333	333	333	333	333
		Historic	333	333	333	333	333	333
	Destroy	Dynamic	333	333	333	333	333	333
		Cleansing	333	333	333	333	333	333

Multidimensional Array for NSSN SBIR Phase I

GFCP								
			Engage					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	333	333	333	333	333	333
		Compare	333	333	333	333	333	333
		Restore	333	333	333	333	333	333
	Archive	Working	333	333	333	333	333	333
		Historic	333	333	333	333	333	333
	Destroy	Dynamic	333	333	333	333	333	333
		Cleansing	333	333	333	333	333	333

Multidimensional Array for NSSN SBIR Phase I

GFCP								
			Assess					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	333	333	333	333	333	333
		Compare	333	333	333	333	333	333
		Restore	333	333	333	333	333	333
	Archive	Working	333	333	333	333	333	333
		Historic	333	333	333	333	333	333
	Destroy	Dynamic	333	333	333	333	333	333
		Cleansing	333	333	333	333	333	333

Multidimensional Array for NSSN SBIR Phase I

AN/URT-23 HF			MIW					
			Mining					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	333	330	330	330	330	330
		Passive	333	330	330	330	330	330
	Communi	Query	333	330	330	330	330	330
		Broadcast	333	330	000	000	000	000
Storage	Physical	Memory	221	220	000	000	000	000
		Static	220	220	000	000	000	000
		Mass	110	110	000	333	333	333
	Logical	Address	222	220	000	333	333	333
		Array	111	110	000	333	333	333
		File	000	000	000	333	333	333
		FMS	000	000	000	333	333	333
		DBMS	000	000	000	333	333	333
Manipulation	Analyze	Compute	111	110	000	333	333	333
		Compare	111	110	000	333	333	333
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	000	220	220	220	220	220
		Point	222	220	220	220	220	220
	Discreet	Response	222	220	220	220	220	220
		Process	222	220	220	220	220	220
MMI	Present	Visual	222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

AN/URT-23 HF								
			MCM					
			Search					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	333	330	330	330	330	330
		Passive	333	330	330	330	330	330
	Communi	Query	333	330	330	330	330	330
		Broadcast	000	330	330	330	330	330
Storage	Physical	Memory	000	220	220	220	220	220
		Static	000	220	220	220	220	220
		Mass	000	110	110	110	110	110
	Logical	Address	000	220	220	220	220	220
		Array	000	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	000	110	110	110	110	110
		Compare	000	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	000	220	220	220	220	220
		Point	222	220	220	220	220	220
	Discreet	Response	222	220	220	220	220	220
		Process	222	220	220	220	220	220
MMI	Present	Visual	222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing						000
			000	000	000	000	000	

Multidimensional Array for NSSN SBIR Phase I

AN/URT-23 HF								
			Localize					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

AN/URT-23 HF								
			Detect					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

AN/URT-23 HF								
			Engage					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

AN/URT-23 HF								
			Assess					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

TADIL-A			MIW					
			Mining					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	333	330	330	330	330	330
		Passive	333	330	330	330	330	330
	Communi	Query	333	330	330	330	330	330
		Broadcast	333	330	330	330	330	330
Storage	Physical	Memory	221	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	222	220	220	220	220	220
		Array	111	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	111	110	110	110	110	110
		Compare	111	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	000	220	220	220	220	220
		Point	222	220	220	220	220	220
	Discreet	Response	222	220	220	220	220	220
		Process	222	220	220	220	220	220
MMI	Present	Visual	222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

TADIL-A								
			MCM					
			Search					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	333	330	330	330	330	330
		Passive	333	330	330	330	330	330
	Communi	Query	333	330	330	330	330	330
		Broadcast	333	330	330	330	330	330
Storage	Physical	Memory	221	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	222	220	220	220	220	220
		Array	111	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	111	110	110	110	110	110
		Compare	111	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	000	220	220	220	220	220
		Point	222	220	220	220	220	220
	Discreet	Response	222	220	220	220	220	220
		Process	222	220	220	220	220	220
MMI	Present	Visual	222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing						000
			000	000	000	000	000	

Multidimensional Array for NSSN SBIR Phase I

TADIL-A								
			Localize					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

TADIL-A								
			Detect					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

TADIL-A								
			Engage					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

TADIL-A								
			Assess					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisition	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulation	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distribution	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintenance	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

TADIL-J			MIW					
			Mining					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisitio	Sense	Active	333	330	330	330	330	330
		Passive	333	330	330	330	330	330
	Communi	Query	333	330	330	330	330	330
		Broadcast	333	330	330	330	330	330
Storage	Physical	Memory	221	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	222	220	220	220	220	220
		Array	111	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulati	Analyze	Compute	111	110	110	110	110	110
		Compare	111	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distributio	Broadcast	Multi-poin	000	220	220	220	220	220
		Point	222	220	220	220	220	220
	Discreet	Response	222	220	220	220	220	220
		Process	222	220	220	220	220	220
MMI	Present	Visual	222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintena	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

TADIL-J								
			MCM					
			Search					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisitio	Sense	Active	333	330	330	330	330	330
		Passive	333	330	330	330	330	330
	Communi	Query	333	330	330	330	330	330
		Broadcast	333	330	330	330	330	330
Storage	Physical	Memory	221	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	222	220	220	220	220	220
		Array	111	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulati	Analyze	Compute	111	110	110	110	110	110
		Compare	111	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distributio	Broadcast	Multi-poin	000	220	220	220	220	220
		Point	222	220	220	220	220	220
	Discreet	Response	222	220	220	220	220	220
		Process	222	220	220	220	220	220
MMI	Present	Visual	222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintena	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing						000
			000	000	000	000	000	

Multidimensional Array for NSSN SBIR Phase I

TADIL-J								
			Localize					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisitio	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulati	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distributio	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintena	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

TADIL-J								
			Detect					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisitio	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulati	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distributio	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintena	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

TADIL-J								
			Engage					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisitio	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulati	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distributio	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintena	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Multidimensional Array for NSSN SBIR Phase I

TADIL-J								
			Assess					
			Orient	Maneuver	Sensor	Determin	Define	Relate
Acquisitio	Sense	Active	330	330	330	330	330	330
		Passive	330	330	330	330	330	330
	Communi	Query	330	330	330	330	330	330
		Broadcast	330	330	330	330	330	330
Storage	Physical	Memory	220	220	220	220	220	220
		Static	220	220	220	220	220	220
		Mass	110	110	110	110	110	110
	Logical	Address	220	220	220	220	220	220
		Array	110	110	110	110	110	110
		File	000	000	000	000	000	000
		FMS	000	000	000	000	000	000
		DBMS	000	000	000	000	000	000
Manipulati	Analyze	Compute	110	110	110	110	110	110
		Compare	110	110	110	110	110	110
	Transact	Add	000	000	000	000	000	000
		Delete	000	000	000	000	000	000
		Change	000	000	000	000	000	000
Distributio	Broadcast	Multi-poin	220	220	220	220	220	220
		Point	220	220	220	220	220	220
	Discreet	Response	220	220	220	220	220	220
		Process	220	220	220	220	220	220
MMI	Present	Visual	'222	'222	'222	'222	'222	'222
		Aural	000	000	000	000	000	000
		Tactile	222	222	222	222	222	222
	Control	System	222	222	222	222	222	222
		Functions	222	222	222	222	222	222
		Applicatio	222	222	222	222	222	222
Maintena	Update	Audit	000	000	000	000	000	000
		Compare	000	000	000	000	000	000
		Restore	000	000	000	000	000	000
	Archive	Working	000	000	000	000	000	000
		Historic	000	000	000	000	000	000
	Destroy	Dynamic	000	000	000	000	000	000
		Cleansing	000	000	000	000	000	000

Appendix C
Small Business Innovation Research
Submarine Combat System C4I and IM&M Technology

Briefing of SBIR Phased Approach

Small Business Innovation Research
SUBMARINE COMBAT SYSTEM C4I AND IM&M TECHNOLOGY

Darlington Incorporated
2361 Jefferson Davis Hwy, Suite 610
Arlington, VA 22202

31 January 1996

darlington incorporated

OBJECTIVE

SBIR for IM&M Technology Insertion

- Develop a technical approach that defines, analyzes, and evaluates the current C4I environment and prescribes the information management practices, hardware integration opportunities, & improvements to C4I that must be achieved to meet the following goals:

- **Improve quality / expand accessibility of information**
- **Propose architectural refinements for anticipated demand**
- **Provide products for future development**
- **Provide model of information environment**

APPROACH FOR INSERTION OF IM&M TECHNOLOGY IN NSSN C3IS

PHASE 1

- FACTOR SSN MISSIONS, SYSTEMS & IM&M METHODS
- ANALYZE FACTORS TO IDENTIFY OPTIMUM APPLICATION OF NEW IM&M TECHNOLOGY

PHASE 2

- APPLY CANDIDATE IM&M METHODS TO APPROPRIATE NSSN MISSION / SYSTEM FUNCTIONS
- PRODUCE PROTOTYPES OF IM&M METHODS IN NSSN MODEL / MOCK-UP

PHASE 3

- PRODUCE IM&M PRODUCTS (EMBEDDED HARDWARE AND/OR MIDDLEWARE SOFTWARE)

ANALYTICAL MODEL

(INVESTIGATE NSSN ARCHITECTURE TO OPTIMIZE IM&M APPLICATION)

IM&M INSERTION

QUANTITATIVE

RELATIVE RANK

ENTITY HIERARCHY

EMERGENT MISSIONS

PROTOTYPE IM&M OPTIMIZATION

(APPLY NEW IM&M TECHNOLOGY TO CANDIDATE NSSN SYSTEMS AND MISSION AREAS TO DEMONSTRATE DESIGN IMPROVEMENTS)

OPEN ARCHITECTURE MOCK-UP OF SSN C4I & ECS

DEMONSTRATION OF INTELLIGENT BROKER IN SSN C4I & ECS

DEMONSTRATION OF MOBILE BROKER IN SSN C4I & ECS

DEMONSTRATION OF VIRTUAL DIAGNOSTICS AND HYBRID INFORMATION EXCHANGE

PRODUCE IM&M AGENTS

(PRODUCE AGENTS THAT RESIDE IN COMPLEX SYSTEMS)

INTELLIGENT BROKERS

MOBILE BROKERS

VIRTUAL DIAGNOSTIC DEVICE

VIRTUAL TRANSLATOR

PHASE I | **PHASE II** | **PHASE III**

ANALYTICAL MODEL

(INVESTIGATE NSSN ARCHITECTURE TO OPTIMIZE IM&M APPLICATION)

IM&M INSERTION

QUANTITATIVE

RELATIVE RANK

ENTITY HIERARCHY

EMERGENT MISSIONS

PROTOTYPE IM&M OPTIMIZATION

(APPLY NEW IM&M TECHNOLOGY TO CANDIDATE NSSN SYSTEMS AND MISSION AREAS TO DEMONSTRATE DESIGN IMPROVEMENTS)

OPEN ARCHITECTURE MOCK-UP OF SSN C4I & ECS

DEMONSTRATION OF INTELLIGENT BROKER IN SSN C4I & ECS

DEMONSTRATION OF MOBILE BROKER IN SSN C4I & ECS

PRODUCE IM&M AGENTS

(PRODUCE AGENTS THAT RESIDE IN COMPLEX SYSTEMS)

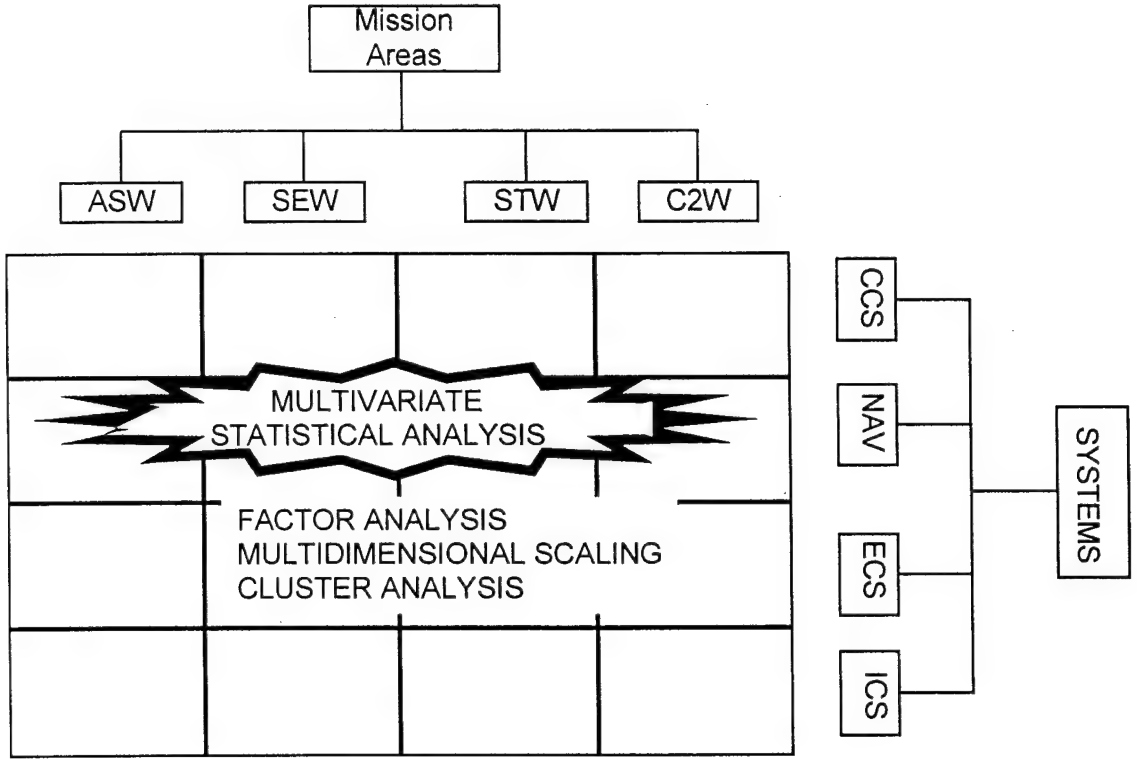
INTELLIGENT BROKERS

MOBILE BROKERS

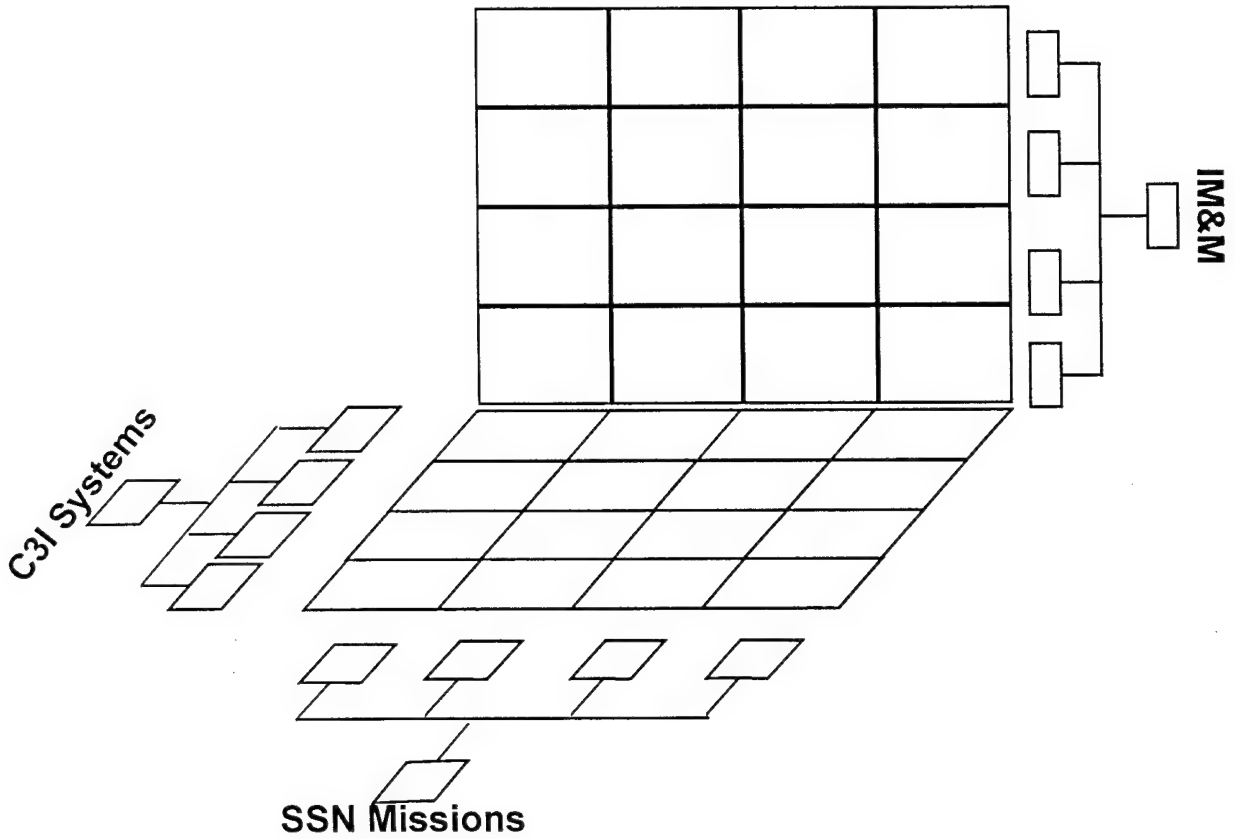
VIRTUAL DIAGNOSTIC

PHASE I | **PHASE II** | **PHASE III**

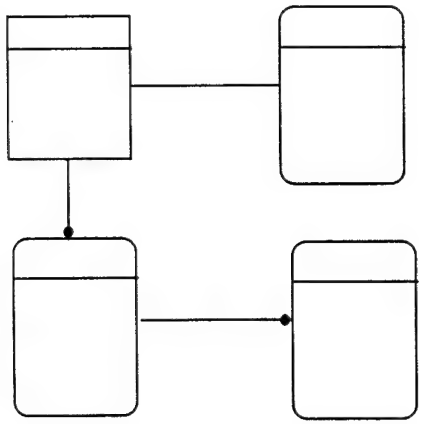
PRECEDENCE OF CONCEPT FOR PHASE I SBIR



CONCEPT OF PHASE I SBIR
MISSIONS vs SYSTEMS vs IM&M



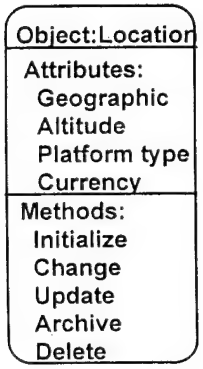
STEPS OF PHASE I ANALYSIS



FACTOR ANALYSIS

USING INFORMATION MANAGEMENT TOOLS

FUNCTION FLOW DIAGRAMS
DATA ELEMENT DICTIONARY
ENTITY RELATIONSHIPS

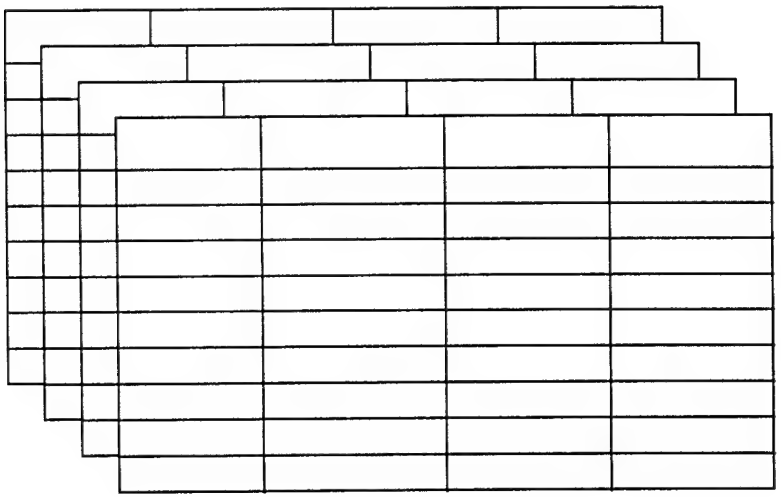


OBJECT ORIENTED ANALYSIS

USING VARIOUS METHODS

BOOCH
COAD/YOURDIN
RTOOSA

STEPS OF PHASE I ANALYSIS
(CONTINUED)



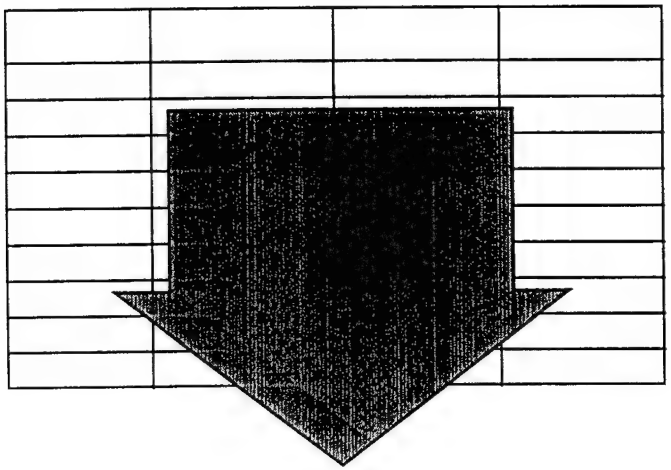
LINKED SPREADSHEETS GIVE THREE DIMENSIONS OF CELL ENTRIES

ENTRIES CAN BE SORTED BY VALUE IN MULTIDIMENSION SCALING

ENTRIES CAN BE SORTED BY TYPE IN CLUSTER ANALYSIS

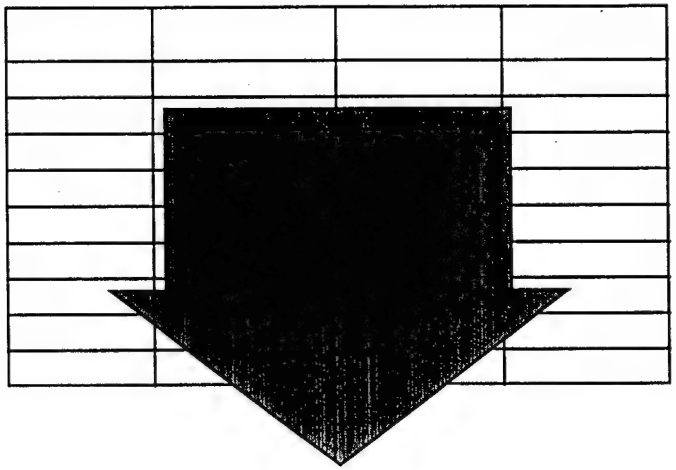
STEPS OF PHASE I ANALYSIS
(CONTINUED)

MULTIDIMENSION SCALING



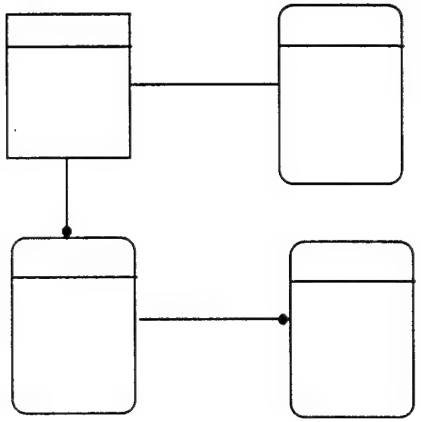
NUMERICAL COMPARISON OF ENTITIES

CLUSTER ANALYSIS



FREQUENCY CORRELATION OF ENTITIES

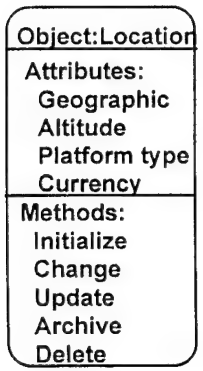
PRODUCTS OF PHASE I ANALYSIS



FACTOR ANALYSIS

USING INFORMATION MANAGEMENT TOOLS

FUNCTION FLOW DIAGRAMS
DATA ELEMENT DICTIONARY
ENTITY RELATIONSHIPS

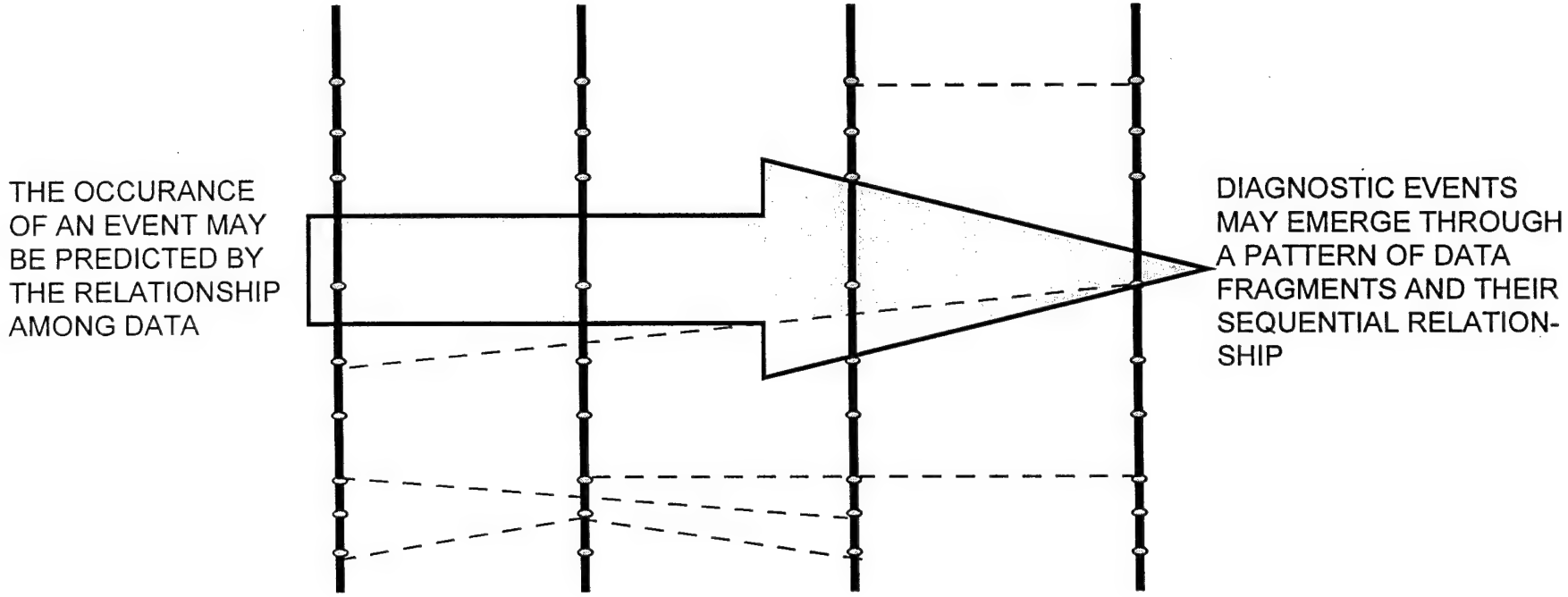


OBJECT ORIENTED ANALYSIS

USING VARIOUS METHODS

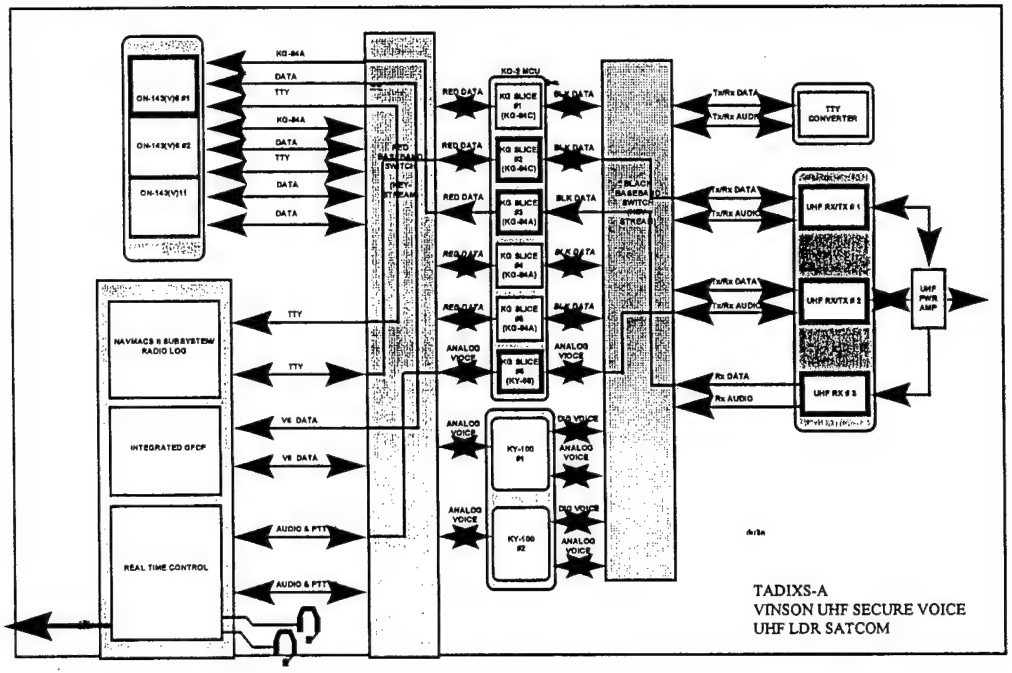
BOOCH
COAD/YOURDIN
RTOOSA

SYNCHRONIC ANALYSIS



SEQUENTIAL RELATIONSHIPS AMONG DATA, OBSERVED AT DIFFERENT INTELLIGENT BROKERS AS DETERMINED BY A COMMON TIME GRID

PLACEMENT OF INTELLIGENT BROKERS



MUST CONSIDER ACCESSIBILITY AND AVAILABILITY OF DATA FRAGMENTS WITHIN THE NSSN ECS AS WELL AS TIMING WITHIN THE VIRTUAL DIAGNOSTIC NET

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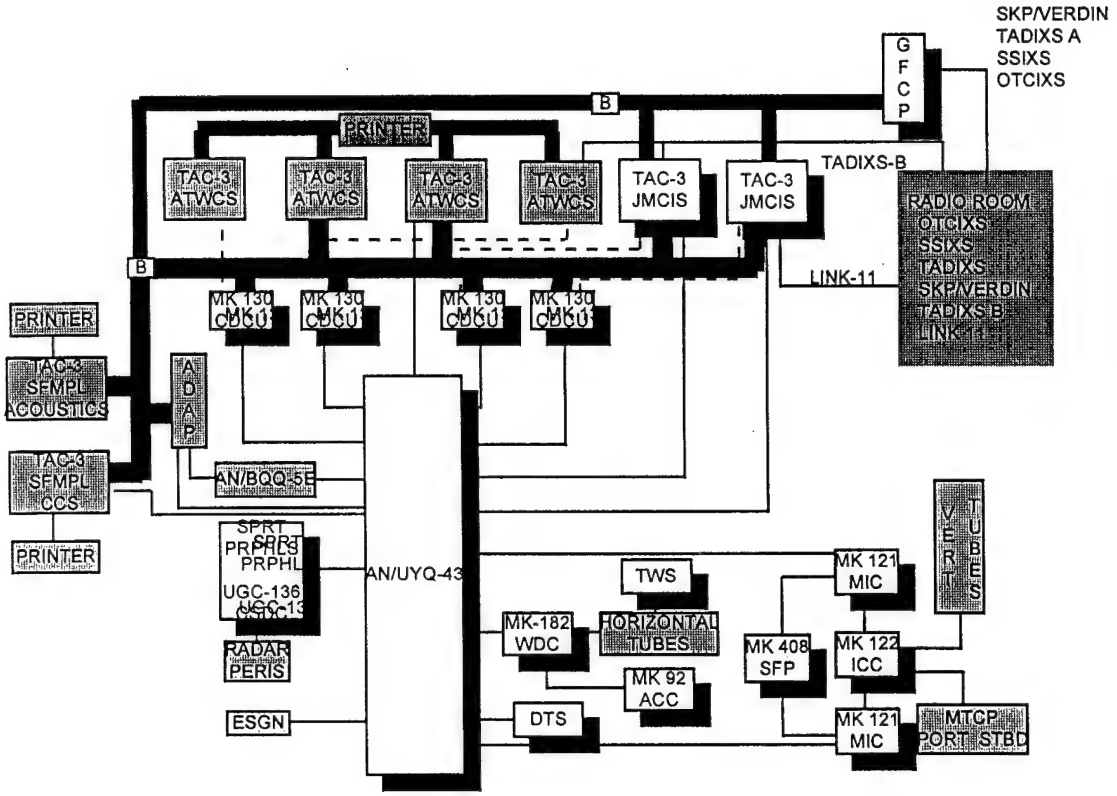
INVESTIGATE LEGACY SYSTEMS



USE LEGACY SYSTEM FUNCTIONS TO PROTOTYPE NSSN ECS DATA FRAGMENT SELECTION BY INTELLIGENT BROKERS

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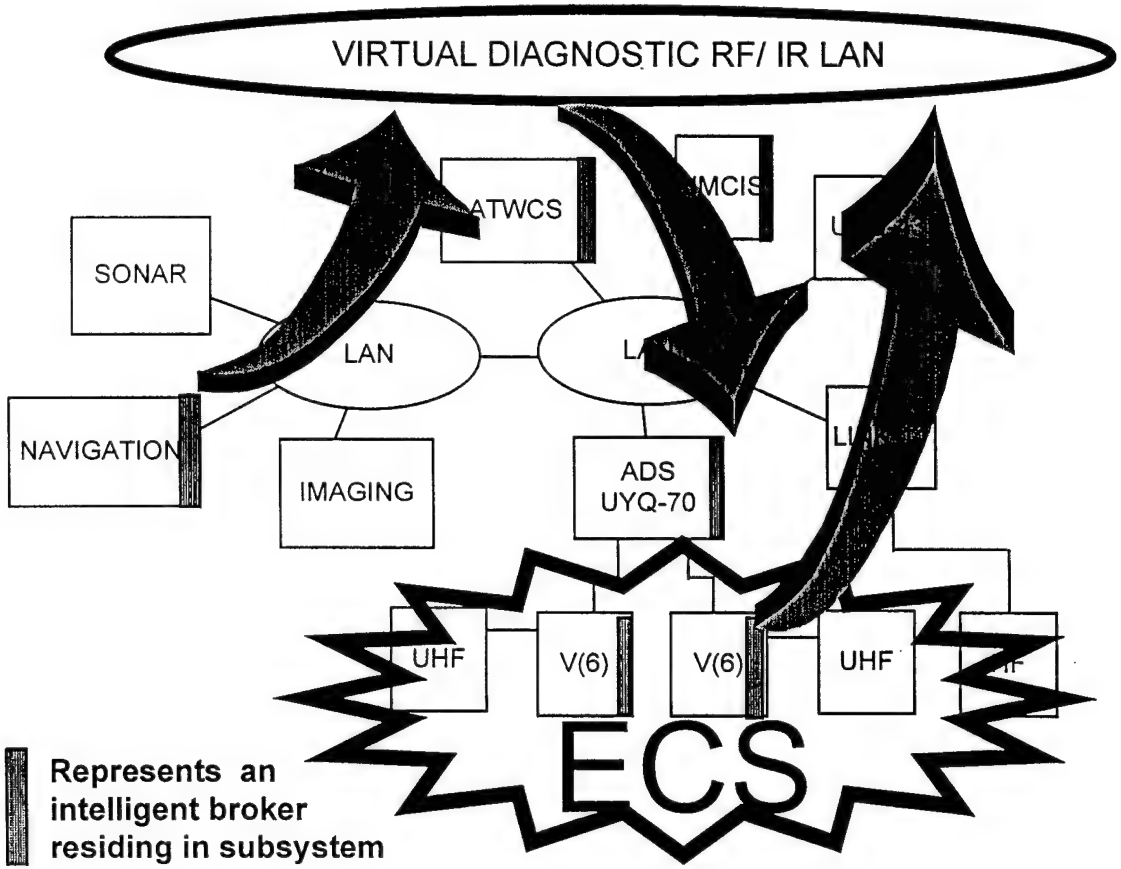
INTELLIGENT BROKERS TRANSFER DIAGNOSTIC DATA



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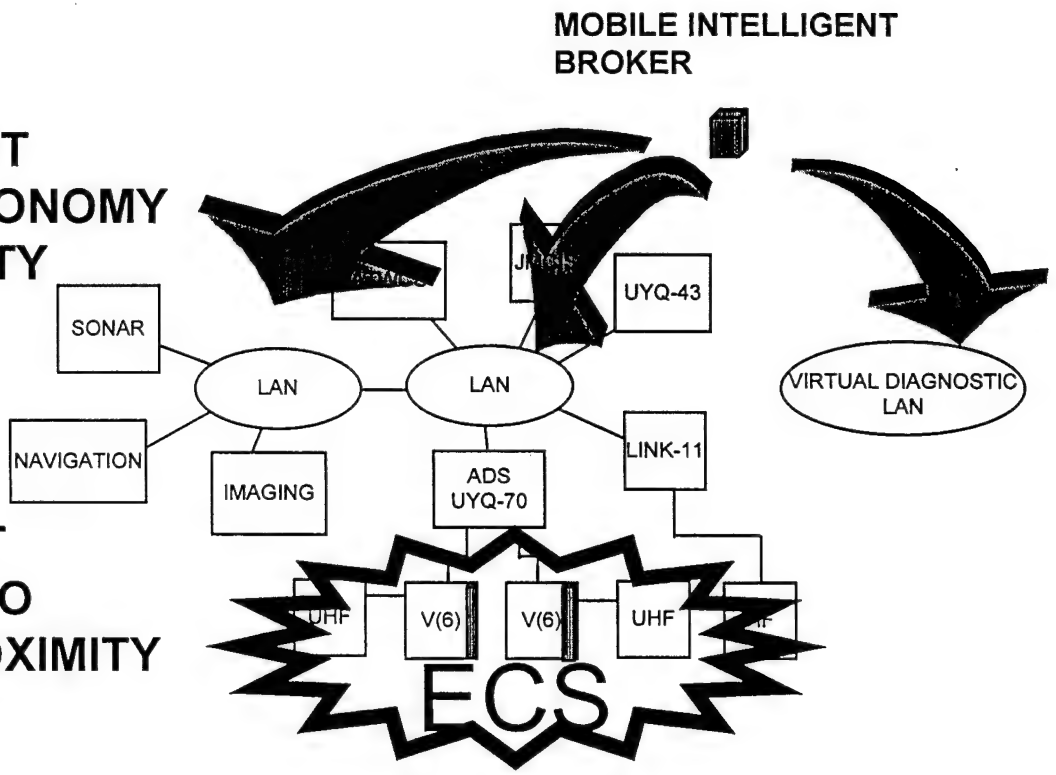
MOBILE INTELLIGENT BROKER ROAMS AMONG HOST LANS

THE MOBILE NTELLIGENT BROKER USES THE TAXONOMY AND DATA ACCESSIBILITY DEVELOPED FOR THE VIRTUAL DIAGNOSTICS AND MIDDLEWARE FILTERS TO REPRESENT USER REQUIREMENTS TO EACH HOST WITHIN PROXIMITY



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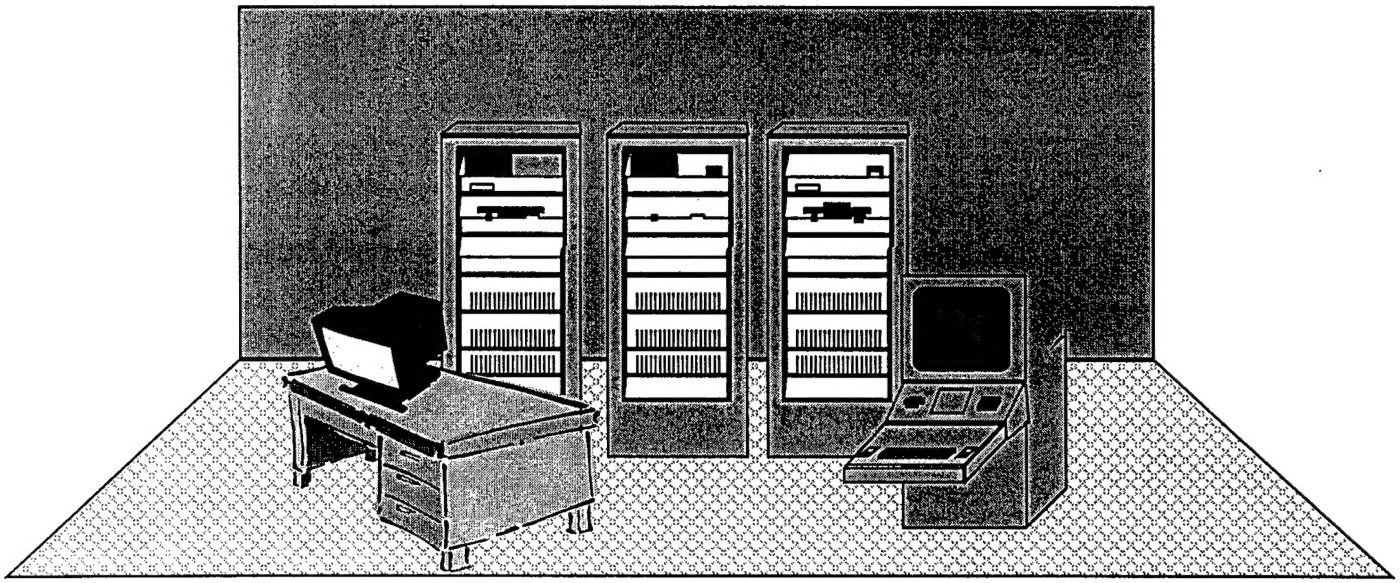
APPROACH TO PHASE II

- APPLY THE IM&M CONCEPTS OF META-DATA AND VIRTUAL DIAGNOSTICS TO NSSN ECS IN MIW
- PROTOTYPE THE FOLLOWING
  - ECS INFORMATION DATA FLOW
  - INTELLIGENT BROKERS
  - VIRTUAL DIAGNOSTIC DEVICE

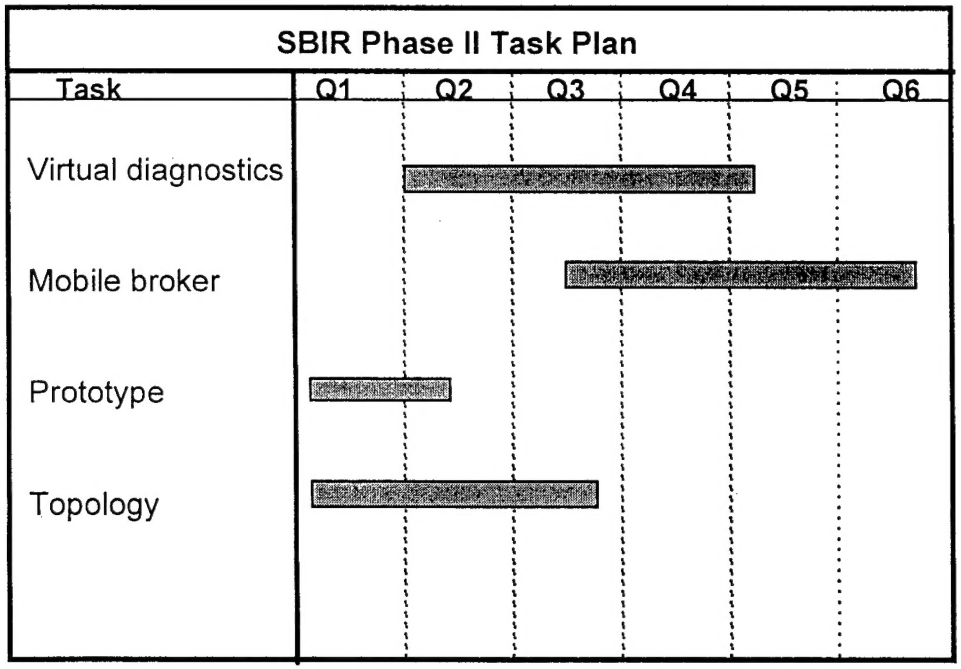
NSSN ECS MOCK-UP WILL PROVIDE TEST BED FOR SBIR PHASE II



USE UYQ-70 AND VME BASED PROTOTYPES OF NSSN ECS ALONG WITH SIMULATORS TO CREATE NSSN ECS DATA FLOW AND ENVIRONMENT FOR VIRTUAL DIAGNOSTICS AND MOBILE INTELLIGENT BROKER

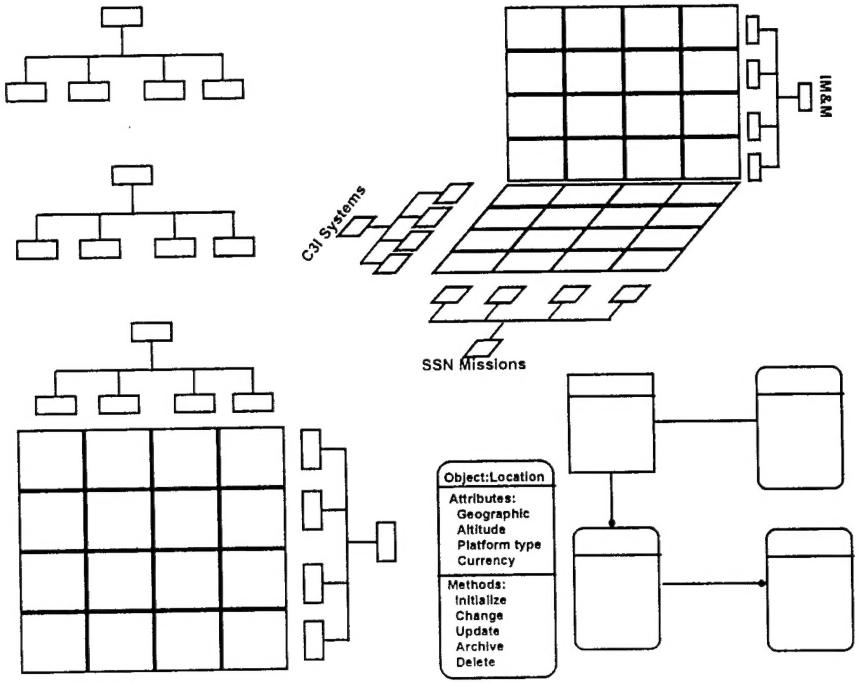
darlington incorporated

SBIR PHASE II SCHEDULE



darlington incorporated

APPLICATION TO OTHER AGENCIES



SPACE AND NAVAL WARFARE COMMAND IS ENGAGED IN WARFARE ARCHITECTURE DEFINITIONS USING SIMILAR TECHNIQUES

VARIOUS JOINT AGENCIES ARE ENGAGED IN DEVELOPMENT OF INTEROPERABLE TEST METHODS AND COMMUNICATIONS FORMATS USING SIMILAR TECHNIQUES

THE SBIR PHASE I RESULTS DEMONSTRATE A STRUCTURED AND MORE RIGOROUS TREATMENT OF SYSTEM ANALYSIS THAN CURRENTLY USED

ANALYTICAL MODEL

(INVESTIGATE NSSN ARCHITECTURE TO OPTIMIZE IM&M APPLICATION)

- IM&M INSERTION
- QUANTITATIVE
- RELATIVE RANK

PROTOTYPE IM&M OPTIMIZATION

(APPLY NEW IM&M TECHNOLOGY TO CANDIDATE NSSN SYSTEMS AND MISSION AREAS TO DEMONSTRATE DESIGN IMPROVEMENTS)

OPEN ARCHITECTURE MOCK-UP OF SSN C4I & ECS

DEMONSTRATION OF INTELLIGENT BROKER IN SSN C4I & ECS

DEMONSTRATION OF MOBILE BROKER IN SSN C4I & ECS

DEMONSTRATION OF VIRTUAL DIAGNOSTICS AND HYBRID INFORMATION EXCHANGE

PRODUCE IM&M AGENTS

(PRODUCE AGENTS THAT RESIDE IN COMPLEX SYSTEMS)

- INTELLIGENT BROKERS
- MOBILE BROKERS

PHASE I | **PHASE II** | **PHASE III**